THIRD LIBERTY LOAN
BUY A BOND TO-DAY

Vol. 5. APRIL, 1918 No. 4.

JOURNAL
OF THE
BOSTON SOCIETY
OF
CIVIL ENGINEERS

Published monthly, excepting July and August, by the Society,
715 Tremont Temple, Boston, Massachusetts.

Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass.
under Act of August 24, 1912.

Subscription Price, $4.00 a year (Ten Numbers)
50 Cents a Copy

Copyright, 1918, by the Boston Society of Civil Engineers.

BOSTON SOCIETY OF CIVIL ENGINEERS

OFFICERS, 1918-1919

PRESIDENT

CHARLES M. SPOFFORD

VICE-PRESIDENTS

CHARLES W. SHERMAN
(Term expires March, 1919)

LEONARD C. WASON
(Term expires March, 1920)

SECRETARY AND LIBRARIAN

S. EVERETT TINKHAM

TREASURER

FRANK O. WHITNEY

DIRECTORS

CLARENCE T. FERNALD
(Term expires March, 1919)

LEWIS E. MOORE
(Term expires March, 1919)

JOHN L. HOWARD
(Term expires March, 1920)

EDWIN H. ROGERS
(Term expires March, 1920)

PAST PRESIDENTS
(Members of the Board)

CHARLES R. GOW　RICHARD A. HALE　GEORGE C. WHIPPLE

NOMINATING COMMITTEE

GEORGE A. CARPENTER
EDGAR S. DORR
HENRY B. WOOD
To serve one year

EDMUND M. BLAKE
CHARLES T. MAIN
ARTHUR T. SAFFORD
To serve two years

PAST PRESIDENTS (Members of the Committee)

JAMES W. ROLLINS　FREDERIC H. FAY　HARRISON P. EDDY

Editor — WILLIAM L. BUTCHER
715 Tremont Temple, Boston

Vol. V APRIL, 1918 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, APRIL 17, 1918,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Commander H. R. Stanford, Civil Engineer, U.S.N., will give a talk on "The Pearl Harbor Dry Dock, Hawaii." The talk will be illustrated with lantern slides.

S. E. TINKHAM, *Secretary*.

PAPERS IN THIS NUMBER.

Address at the Annual Meeting. George C. Whipple.

"Economy in the Use of Fuel in Power Stations." Chas. H. Parker.

Memoir of deceased member.

Reprints from this publication, which is copyrighted, may be made provided full credit is given to the author and the Society.

Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

BOSTON, MASS., February 27, 1918. — A special meeting of the Boston Society of Civil Engineers was held this evening at the Society rooms, and was called to order by the President, George C. Whipple, at 7.45 o'clock.

There were 27 members and visitors present.

Mr. Clayton W. Mayers, of the Aberthaw Construction Company, was present and read a paper entitled, "Economic Design of Concrete Buildings." This paper was printed in the February, 1918, number of the JOURNAL.

The discussion following the reading of the paper was opened by a short communication from Mr. Joseph R. Worcester, which was read by the Secretary.

Others who took part in the discussion were Burtis S. Brown, John R. Nichols, Leslie H. Allen and Clayton W. Mayers.

After passing a vote of thanks to Mr. Mayers, who is not a member of the Society, for his courtesy in presenting so valuable and interesting a paper, the Society adjourned.

S. E. TINKHAM, *Secretary.*

BOSTON, MASS., March 20, 1918. — The seventieth annual meeting of the Boston Society of Civil Engineers was held at the Boston City Club, Ashburton Place; Boston, on Wednesday, March 20, 1918.

The thirty-sixth annual dinner which preceded the business meeting was served in the auditorium of the Clubhouse at half past one o'clock, the President of the Society, Prof. George C. Whipple, presiding.

During the serving of the dinner, Past President Richard A. Hale read the Roll of Honor of the Society, a list of its members who are serving in the army or navy of the United States or any of its allies. This list is printed in the April number of the JOURNAL.

At the call of the President, the Secretary read extracts from letters written by three members who are with the American Expeditionary Force in France, Captain John F. Osborn, 101st Engineer Regiment; Captain Lewis E. Moore, Engineer Reserve

Corps, and Major Benjamin W. Guppy, 114th Engineer Reserve Corps. For these extracts from personal letters the Society is indebted to Mr. C. W. Sherman, Mrs. L. E. Moore and Mr. A. B. Corthell.

The Society was honored by the presence, for a short time, of His Honor Andrew J. Peters, Mayor of Boston, who made a brief address extending the hearty welcome of the City to the members of the Society.

The President then introduced Mr. Robert Ridgway, of New York, Engineer of Subway Construction, who gave a most interesting talk on "The New York Subways," which was very fully illustrated with lantern slides. At the conclusion of the talk, on motion of Past President Eddy, a unanimous vote of thanks to Mr. Ridgway was passed for his courtesy in presenting to the Society so graphic a description of the New York subway work.

At five o'clock the business meeting was called to order, in Rooms B and C of the Clubhouse, by President Whipple.

The record of the February meeting of the Society was read and approved.

The President announced the death of Thomas Aspinwall, a member of the Society, which occurred on March 2, 1918, and by vote the President was requested to appoint a committee to prepare a memoir. The President has named as the committee, Messrs. Edwin H. Lincoln and Desmond FitzGerald.

The annual report of the Board of Government was read by the Secretary, and by vote was accepted and ordered printed in the JOURNAL.

On motion of Mr. C. W. Sherman, it was voted unanimously: That the dues for the year 1918–19 be abated to all members in the military or naval service of the United States or its allies; and that a sum not exceeding one thousand dollars be appropriated from the income of the Permanent Fund to reimburse the Current Fund of the Society for the resulting loss.

The Treasurer read his annual report, and by vote it was accepted and ordered printed in the JOURNAL.

The Secretary read his annual report which was also accepted and ordered printed in the JOURNAL.

The Librarian read the annual report of the Committee on the Library, which was accepted and ordered printed in the JOURNAL.

Mr. David A. Ambrose, chairman of the Committee on Social Activities, read the report of that committee, and by vote it was accepted and ordered printed in the JOURNAL.

Mr. C. W. Sherman, in the absence of its chairman, presented and read the report of the Committee on Run-off Available for Water Power Purposes. The report was accepted as a progress report and ordered printed in the JOURNAL and the committee continued.

By vote, the appointment of the several committees of the Society was referred to the Board of Government with full powers.

The tellers of election, Messrs. Albert F. Brown and William A. Bryant, submitted the result of the letter ballot for officers of the Society for the ensuing year, and in accordance with their report, the President announced that the following officers had been elected:

President — Charles M. Spofford.

Vice-President (for two years) — Leonard C. Wason.

Secretary — S. Everett Tinkham.

Treasurer — Frank O. Whitney.

Directors (for two years) — John L. Howard and Edwin H. Rogers.

Members of Nominating Committee (to serve two years) — Charles T. Main, Edmund M. Blake and Arthur T. Safford; (to serve one year) — George A. Carpenter, Edgar S. Dorr and Henry B. Wood.

The Secretary stated that a request had been received from the committee in charge of the campaign for the Third Liberty Loan in Boston and the proposed parade in its interest to be held in Boston on April 6 next, asking the Society's assistance in this work. After a discussion it was voted to refer the matter to the Board of Government with full powers.

The retiring President, George C. Whipple, then delivered the annual address of the president, which will be printed in the April number of the JOURNAL.

The meeting then adjourned to participate in the annual smoker which was held in the auditorium of the Club.

The smoker was of the same general character as those of former years. Music was furnished by a Jazz Band, and light refreshments were served.

The singing of the old songs and several new ones which had been written by members for the occasion was more enthusiastic if possible than ever before. The entertainment was of a more varied character than usual. Two sets of motion pictures were shown, depicting war scenes, one entitled, "The German Curse in Russia," and the other, "Italy on the Firing Line."

Two entertainers were also presented, — Mr. Darling, "the cartoonist and mud-pie man," and Mr. Lorraine, a monologist and imitator.

A new feature was inaugurated at this smoker, the first annual line-up, an informal reception to the new officers and members who have joined the Society since the last annual meeting.

The attendance at the several functions, while not as large as last year, was more than 260.

S. E. TINKHAM, *Secretary.*

ANNUAL MEETING OF THE SANITARY SECTION.

BOSTON, MASS., March 6, 1918. — The annual meeting of the Sanitary Section of the Boston Society of Civil Engineers was held this evening in the Society Library in Tremont Temple. The meeting was called to order at 7.40 o'clock by Chairman Frank A. Marston. The minutes of the January meeting were read and approved. The annual report of the Executive Committee was read by the Clerk, and it was voted that it be accepted and placed on file.

The committee appointed to study and collect data upon the distribution of excessive rainfall in Boston and vicinity was not ready to report any progress, which was also the case with the Committee on Outfall Sewers.

Mr. Robert Spurr Weston, chairman of the Nominating

Committee, presented the names of the candidates for officers of this section to be filed at this time, as follows:

For Chairman — Almon I. Fales.
For Vice-Chairman — Edgar S. Dorr.
For Clerk — Henry A. Varney.
For additional members of the Executive Committee:
William Nelson.
Alfred O. Doane.
Arthur L. Gammage.

There were no other nominations. It was voted that the Clerk be instructed to cast one ballot for the officers as nominated, and they were declared elected for the ensuing year.

The paper of the evening, " Economy in the Use of Fuel in Power Stations," was read by Charles H. Parker, superintendent of the Generating Department, Edison Electric Illuminating Company of Boston. The paper, which was illustrated by a reflectroscope, was of great interest to those present and was discussed by Mr. Doane and others.

There were fifty-three members and guests present.

Through the courtesy of the Edison Electric Illuminating Company about thirty members inspected the company's Power Plant at L Street, South Boston, during the afternoon. A vote of thanks was extended to Mr. Parker for the very valuable paper, and to the Edison Company for the privilege of inspecting their plant.

The meeting was adjourned at 9.50.

HENRY A. VARNEY, *Acting Clerk.*

ANNUAL REPORTS.

ANNUAL REPORT OF THE BOARD OF GOVERNMENT FOR THE YEAR 1917–1918.

BOSTON, MASS., March 20, 1918.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the Constitution, the Board of Government presents its report for the year ending March 20, 1918.

The total membership of the Society a year ago was 966, of whom 846 were members, 77 juniors, 5 honorary members, 30 associates, and 8 were members of the Sanitary Section only.

The total loss in membership during the year has been 75, of whom 35 resigned, 29 forfeited membership on account of non-payment of dues, and 11 have died.

There has been added to the Society during the year, by election, a total of 26 members in all grades; 8 juniors, 1 associate and 1 member of the Sanitary Section have been transferred to the grade of member. Six applicants have been elected but have not completed their membership.

The following past presidents have been made honorary members during the year: John R. Freeman, George F. Swain, Ira N. Hollis and Howard A. Carson.

The present membership of the Society consists of 8 honorary members, 813 members, 64 juniors, 26 associates and 6 who are of the Sanitary Section only, making a total membership of 917.

The loss by death during the year has been 11. The record is as follows:

Otis F. Clapp, died March 3, 1917.
Joseph P. Davis, died March 31, 1917.
Albert S. Glover, died April 23, 1917.
Franklin B. Locke, died May 11, 1917.
Stanley A. Miller, died May 13, 1917.
Frank A. Pierce, died August 7, 1917.
William S. Johnson, died October 27, 1917.
Henry A. Herrick, died December 14, 1917.
Chauncey D. Bryant, died January 5, 1918.
Charles W. Gay, died February 1, 1918.
Thomas Aspinwall, died March 2, 1918.

In the death of Mr. Bryant, the Society suffers its first loss of a member who died in the war service of his country.

Under authority of By-Law 8, the Board of Government has remitted the dues of 21 members of the Society, of which number 14 are members who are now in war service and whose dues had not been paid at close of Society year.

Thirteen meetings have been held during the year, ten regular and three special meetings. The average attendance at these meetings was 134+, the largest being 360 and the smallest 27.

The following papers and addresses have been given:

March 21, 1917. — Address of Retiring President Richard A. Hale. Address of Mr. Frank M. Williams, state engineer of New York, on "The New York Barge Canal and Terminal Connections." (Illustrated.)

April 11, 1917. — (Special) Military Night. Addresses on the following topics: By George C. Whipple, "The Engineering Society in War Times"; by Lieut.-Col. W. P. Chamberlain, "Military Sanitation" (illustrated); by Capt. F. B. Downing, "Organization and Duties of Engineer Troops" (illustrated); by Capt. J. F. Osborn, "Engineering Instruction now being Given by the First Corps Cadets and the Formation of a New Engineer Regiment" (illustrated).

April 18, 1917. — Charles R. Gow, "The History and Present Status of the Concrete Pile Industry." (Illustrated.)

May 16, 1917. — Lieut. George D. Murray, "The Problems of Aviation as Applied to the Navy" (illustrated). Greely S. Curtis, "Various

Forms of Air Planes" (illustrated). Prof. Edwin B. Wilson, "Theory of the Aeroplane." Clifford L. Webster, "Experiences in Aerial Navigation."

September 19, 1917. — Frank A. Barbour, "Cantonment Construction Work at Camp Devens" (illustrated). Addresses on Cantonment Work by Capt. Edward Canfield, Jr., Frank Rogers, Maj. Glenn I. Jones and Leonard Metcalf.

October 17, 1917. — Henry I. Harriman, "Water Powers of New England." (Illustrated.)

November 21, 1917. — George C. Whipple, "Russia — An Opportunity for American Engineers."

December 19, 1917. — Charles T. Main, "Foundations of New Technology Buildings" (illustrated). Sanford E. Thompson, "Theoretical Design of the Structures of the New Technology Buildings" (illustrated).

January 11, 1918. (Special) John R. Freeman, "The Experiences of an Engineer in the Far East." (Illustrated.)

January 23, 1918. — Frank B. Walker, "The Engineering Features in Connection with Loading and Hauling Iron Ore from Mesabi Range to Lake Docks." (Illustrated.)

February 20, 1918. — Thomas C. Atwood, "The Submarine Menace and the Squantum Destroyer Plant." (Illustrated.)

February 27, 1918. — (Special) Clayton W. Mayers, "Economy in the Design of Concrete Buildings."

Three informal meetings have been held in the Society rooms during the year, at which talks on military matters were given as follows:

April 25, 1917. — Sanford E. Thompson, "Work being done on Store Houses for Supplies for the Army and Navy." Capt. H. S. Wonson, Supply Officer of the Eighth Massachusetts Infantry, "Work of the Commissary Department."

May 2, 1917. — Major Richard K. Hale, "Work of the Field Artillery." (Illustrated.)

May 9, 1917. — Major Edwin T. Cole, "The Making of War Maps."

The average attendance at these meetings was 36.

The Sanitary Section has held five meetings, with an average attendance of 33. The following papers have been presented at the meetings of the Section:

March 7, 1917. — George W. Fuller, "What shall be the Limitation in the Pollution of River Waters so that They may be Safely Purified by Modern Water Treatment Plants."

June 6, 1917. — Robert Spurr Weston, "Biological Self-Purification of Coweeset River, Brockton, Mass." (Illustrated.)

November 1, 1917. — Major Glenn I. Jones, "Precautions taken to Safeguard the Health of Workmen at Camp Devens."

December 5, 1917. — Stephen DeM. Gage and S. K. Nason, "Sanitary Conditions of Swimming Pools." (Illustrated.)

January 2, 1918. — J. Leslie Woodfall *et al.*, "Discussion on Sewer Pipe Joints."

A Committee on Military Affairs was appointed early in the year, and its work has been of much value to the Society. It arranged a most interesting special meeting devoted to military matters and several informal meetings at which military topics were discussed, and recommended many valuable books on military subjects which were purchased for the library. Its most important work, however, was raising a fund for the purchase of military equipment for the regiment of engineers enlisted here in Boston.

By an almost unanimous vote, by letter ballot canvassed June 13, 1917, the Society adopted a resolution endorsing the formation of a regiment of engineers by transformation and enlargement of the First Corps of Cadets, and pledging to it the support and assistance of the Society. To carry out this pledge the committee decided to raise, by voluntary contribution from members of the Society, a fund for the purchase of equipment for this regiment not customarily supplied by the War Department. As result of an appeal for subscriptions, a total of $2 200 was received from 195 members, and on August 27, 1917, this sum was turned over to George W. Bunnell, colonel of the 101st Regiment, U. S. Engineers. The sum of $26.58, received since last August, is now on deposit in the Old Colony Trust Company, to the credit of this fund.

Word has recently been received that the whole, or a part of this money, was used to purchase musical instruments for a band, and that this regiment now has the distinction of being the only American regiment of engineers which has a band attached to it.

The members of the Society have freely enlisted in the war service of their country, and at the date of this report there are recorded on the roll of honor of the Society 85 members who are in the war service, and a service banner has been hung in the Society rooms with the proper number of stars.

At the request of the Massachusetts Civil Service Commission, a special committee of the Society was appointed to consider the question of the classification of civil engineers under civil service rules, and to suggest such modifications and changes as would improve the service. This committee devoted much time to the work, and submitted a most valuable report, which was accepted by the board and forwarded to the Civil Service Commission.

The committee on matters of interest to engineers coming before the Massachusetts legislature has been continued and has done much valuable work during the year.

A committee was appointed early in the year to consider any matters of an engineering character which might appropriately be brought to the attention of the State Constitutional Convention. Several meetings of the committee were held, but no definite action was taken.

The committee appointed last year to collect data on the run-off in New England which are available for water-power purposes, was continued this year, and has gathered much valuable data which it is expected will be presented soon in a report to the Society.

The Board of Government has adopted the recommendation of the committee appointed to award the Desmond FitzGerald medal, and has voted not to make an award this year, as in its opinion none of the papers in extent and quality merits the award.

At the May and June meetings a sum not exceeding five hundred dollars was appropriated from the income of the Permanent Fund for improvement and furnishing of the Society rooms. Of this appropriation the sum of $394.08 has been expended for the purchase of the book shelves owned by the New England Water Works Association and abandoned when that association moved to its new room, and for the installation of a ventilation shaft with an electrically driven fan in the large front room. The change has made the room comfortable and quiet for small meetings. All of the meetings of the Sanitary Section have been held in this room during the past year.

By an amendment to the By-Laws, a change has been made in the method of nominating officers, which takes effect the coming year. The new by-law provides for a nominating committee of nine, six members to be elected by letter ballot to serve for a term of two years and the three latest Past Presidents not members of the Board of Government. A further change is made, by which only a single candidate is to be nominated for each office except Directors and members of the Nominating Committee, where two candidates are required to be nominated for each office.

The report of the Editor of the JOURNAL for the calendar year 1917 shows that a total of 787 pages were printed in the ten issues, at a net cost of $1 997.44, or $2.54 per page, as against $1 883.81, or $2.19 per page, in 1916.

The Society by its vote at the February meeting approved the suggestion of the Board in regard to remitting the unpaid dues of members in the war service, by appropriating sufficient money from the income of the Permanent Fund to meet the loss. The Board now recommends that dues for the ensuing year be abated to all members in the military or naval service of the United States; and that the Current Fund be reimbursed for the consequent loss of income by an appropriation from the income of the Permanent Fund.

There has been added to the Permanent Fund during the year $1 799.75. The present value of this fund is $41 687.92, and with the Edmund K. Turner Fund makes the total value of the permanent funds of the Society $42 711.04.

From the Treasurer's report it appears that the revenue for the year applicable to current expenses has been $8 958.40, while the amount expended has been $9 153.89, making an excess of expenditures over revenue of $195.49, which, deducted from the balance on hand at the beginning of the year, makes the total cash on hand in the current fund $377.84.

For the Board of Government,

GEORGE C. WHIPPLE, *President.*

REPORT OF THE TREASURER.

BOSTON, March 1, 1918.

To the Boston Society of Civil Engineers:

Your Treasurer presents the following report for the year 1917–1918:

Detailed data are contained in the appended tabular statements. Table 1 gives the receipts and expenditures for the year: Table 2, comparative balance sheets; and Table 3, investment of the Permanent Fund.

The revenue applicable to current expenses has been $8 958.40, being

$399.65 less than for the preceding year. The current expenses were $9 153.89. The amount of cash on hand is $377.84.

The JOURNAL has been published at a much less expense than last year, the amounts being $3 851.48 and $3 436.92 respectively.

There has been an increase in the Permanent Fund of $1 799.75 after transferring from the income $500 for furnishings and $120 for dues of members in the war.

The note of the Dallas Electric Company for $500 was paid, and $2 000 was invested in 3½% Liberty Bonds; otherwise our investments remain unchanged.

Respectfully submitted,
F. O. WHITNEY, *Treasurer.*

TABLE I. — RECEIPTS AND EXPENDITURES

CURRENT FUND.

Receipts.

Balance from March, 1917	$573.33
Members' dues	7 298.93
Members dues paid from income of Permanent Fund	120.00
Advertisements	1 284.00
Sales of JOURNALS	232.37
Library fines	7.72
Waste paper sold	4.38
Interest on bank balances	11.00
	$9 531.73

Expenditures.

JOURNAL		$3 436.92
Printing, stationery, postage and library supplies (net)		971.10
Rent (net)		1 770.00
Light		60.90
Salaries (except editor)		2 096.00
Reporting		50.00
Stereopticon		40.00
Books		49.56
Binding		115.95
Periodicals		57.75
Incidentals (net)		128.93
Insurance		35.44
Annual meeting and dinner		304.39
Sanitary Section, reporting	$18.00	
Stereopticon	6.00	
Incidentals	12.95	36.95
Cash on hand		377.84
		$9 531.73

PERMANENT FUND.

Receipts.

Cash on hand March, 1917	$866.02
Entrance fees	255.00
Contribution	100.00
Dallas Electric Company, note paid	500.00
Interest	1 764.80
Deficit, March, 1918	34.18
	$3 520.00

Paid Out.

Coöperative bank dues	$900.00
Liberty Bonds purchased	2 000.00
Transferred to furnishing fund	500.00
Transferred to members' dues	120.00
	$3 520.00

E. K. TURNER LIBRARY FUND.

Cash on hand March, 1917	$4.12
Interest on bond	50.00
	$54.12
Books purchased	$24.75
Cash on hand March, 1918	29.37
	$54.12
1 Bond Am. Tel. & Tel. Co., book value	$993.75
Cash	29.37
Total value of fund	$1 023.12

FURNISHING APPROPRIATION.

Received from interest on Permanent Fund	$500.00
Expended	$394.08
Cash on hand March, 1918	105.92
	$500.00

Table 2. — Comparative Balance Sheets.

Assets.	March 17, 1915.	March 1, 1916.	March 1, 1917.	March 1, 1918.
Cash	$1 267.73	$3 163.37	$1 443.47	$478.95
Bonds and notes	29 191.75	30 366.25	33 318.75	34 835.00
Stock	1 950.00	1 950.00	1 950.00	1 950.00
Coöperative banks	3 212.65	4 190.96	4 747.15	5 930.85
Accounts Receivable (rents)	145.83	......	......	......
Library	7 500.00	7 500.00	7 500.00	7 500.00
Furniture	1 950.49	2 405.11	2 405.11	2 405.11
	$45 218.45	$49 575.69	$51 364.48	$53 099.91
Liabilities:				
Permanent Fund	$34 582.13	$37 475.69	$39 888.17	$41 687.92
E. K. Turner Fund	......	1 000.00	997.87	1 023.12
Unexpended appropriations	613.52	......	......	105.92
Current funds	451.31	1 194.89	573.33	377.84
Accounts Payable	121.00	......	......	......
Surplus	9 450.49	9 905.11	9 905.11	9 905.11
	$45 218.45	$49 575.69	$51 364.48	$53 099.91

Table 3. — Investment of the Permanent Fund, March 1, 1918.

Bonds.	Par Value.	Actual Cost.	Value as Carried on Books.
American Tel. & Tel. Co. Col. Tr. 4%, 1929,	$3 000.00	$2 328.75	$2 737.50
Union Elec. Light & Power Co. 5%, 1932	2 000.00	2 050.00	2 050.00
Blackstone Valley Gas & Elec. Co. 5%, 1939,	2 000.00	1 995.00	1 995.00
Dayton Gas Co. 5%, 1930	2 000.00	2 000.00	2 000.00
Milford & Uxbridge St. Ry. 7%, 1923	3 000.00	2 942.50	2 942.50
Railway & Light Securities Co. 5%, 1939	3 000.00	3 000.00	3 000.00
Superior Light & Power Co. 4%, 1931	4 000.00	3 347.50	3 347.50
Wheeling Electric Co. 5%, 1941	4 000.00	3 845.00	3 845.00
Economy Light & Power Co. 5%, 1956	1 000.00	990.00	990.00
Tampa Electric Co. 5%, 1933	2 000.00	2 000.00	2 000.00
Galveston Houston Elec. Ry. Co. 5%, 1954,	2 000.00	1 940.00	1 940.00
Northern Texas Elec. Co. 5%, 1940	2 000.00	1 932.50	1 932.50
Chicago & Northwestern Ry. 5%, 1987	1 000.00	1 102.50	1 102.50
Vermont Power & Mfg. Co. 5%, 1928	1 000.00	965.00	965.00
Am. Tel. & Tel. Co. 5% 1946	1 000.00	993.75	993.75
United States Liberty Loan 3½%, 1947	2 000.00	2 000.00	2 000.00
	$35 000.00	$33 432.50	$33 841.25
Stock.			
15 shares Am. Tel. & Tel. Co.	1 500.00	1 950.00	1 950.00
Total Securities	$36 500.00	$35 382.50	$35 791.25

Coöperative Banks.

25 shares Merchants Coöperative Bank, including interest to March	$1 884.35
25 shares Volunteer Coöperative Bank, including interest to January	2 162.70
25 shares Watertown Coöperative Bank, including interest to March	1 883.80
	$5 930.85
Total value of invested funds	$41 722.10
Cash deficit	34.18
Total value of Permanent Fund	$41 687.92

E. K. Turner Fund.

	Par Value.	Actual Cost.		
Am. Tel. & Tel. Co. 5%, 1946	$1 000.00	$993.75	$993.75	
Cash on hand			29.37	
				1 023.12
				$42.711.04

Furnishing Appropriation.

Cash on hand	105.92
	$42 816.96

We have examined the above report and found it correct.

Arthur W. Dean,
Clarence T. Fernald,
Auditing Committee of Directors of the
Boston Society of Civil Engineers.

Report of the Secretary, 1917–18.

Boston, Mass., March 20, 1918.

S. Everett Tinkham, Secretary, *in account with the* Boston Society of Civil Engineers.

For cash received during the year ending March 20, 1918, as follows:

From entrance fees, new members and transfers:

16 members and associates	at $10 =	$160.00	
10 juniors	at 5 =	50.00	
8 juniors transferred to members	at 5 =	40.00	
1 member, Sanitary Section, transferred to member	at 5 =	5.00	
Total from entrance fees			$255.00

From annual dues for 1917–18, including dues from new members	$7 218.43	
From back dues	26.00	
From dues for 1918–19	54.50	
Total from dues		$7 298.93
From rents		1 300.00
From advertisements		1 284.00
From sale of JOURNALS, reprints and cuts		232.37
From sale of old papers		4.38
From unexpended balance of funds received for joint excursion of June 13, 1917		14.37
From N. E. Water Works Ass'n, for telephone service		9.44
From library fines		7.72
From contribution to building fund		100.00
Total		$10 506.21

The above amount has been paid to the Treasurer, whose receipts the Secretary holds.

We have examined the above report and found it correct.

ARTHUR W. DEAN,
CLARENCE T. FERNALD.
Auditing Committee of Directors of the Boston Society of Civil Engineers.

REPORT OF LIBRARY COMMITTEE, 1917–18.

BOSTON, MASS., March 20, 1918.

To the Boston Society of Civil Engineers:

The Library Committee submits the following report for the year 1917–18.

Since the last report 233 volumes bound in cloth and 524 bound in paper have been added to the library, making a total of 757 accessions.

The cloth-bound volumes in the library now number 9 410, and those bound in paper about 2 500.

During the year 266 books have been loaned to members, and fines amounting to $7.72 have been collected.

The binding of reports and current volumes of magazines has been continued as usual, with the exception of a number of volumes of the English periodicals, which are still incomplete, certain issues having been shipped on vessels that were torpedoed on the way over. Thus far the newsdealers have not been able to supply these issues, and they are exceedingly pessimistic as to the possibility of ever obtaining them. It may also be noted in passing that the subscription price of the English periodicals is no longer a fixed amount, and that American dealers are accepting subscriptions to these publications only with the understanding that the price may increase at any time during the year.

The fact may interest you that the Société des Ingenieurs Civils de France is still publishing its "Memoires," although at longer intervals than before the war, and that only one copy has been lost in transportation since the war began. A new copy was promptly forwarded upon our making application to the Secretary.

Twenty-three volumes on engineering subjects have been purchased for Section 10, and four others — "State Sanitation," in two volumes, by Prof. George C. Whipple; "Business Law for Engineers," by Prof. C. Frank Allen; and "Navigation," by Prof. George L. Hosmer — have been presented to the library by their respective authors. The Society is indebted to Mr. Sanford E. Thompson for a copy of "A Treatise on Concrete, Plain and Reinforced," third edition, 1917, by Messrs. Sanford E. Thompson and Frederick W. Taylor; and a copy of "Street Railway Fares," by Messrs. Dugald C. Jackson and David J. McGrath, has recently been received from Professor Jackson, "with the compliments of the Institute." Of the twenty-three books purchased for Section 10, eighteen were on military engineering and allied subjects.

A list of references on military subjects, begun in a small way at the time of the military meetings last spring, is being kept up, the references posted at that time on the bulletin board having been transferred to cards and other references added. Books on military subjects are indexed in this list as well as in the regular card catalogue.

Miscellaneous contributions of books and pamphlets have been received from the respective offices of Mr. Andrew D. Fuller and Mr. E. W. Bowditch. Early in the year a large collection of pamphlets, consisting chiefly of water reports of cities and towns, was turned over to the Society by the New England Water Works Association. While the greater part of these proved to be duplicates of reports already on the shelves, the collection yielded quite a number of those needed for the completion of the Society's files.

The increasing number of municipal reports obtained from various sources, that could not be accommodated in Section 3 under the former arrangement, have made it necessary to enlarge this section, which work is now in progress, the work of reclassifying, renumbering and recataloguing the section being carried on at the same time.

Respectfully submitted,

S. E. Tinkham,
Henry F. Bryant,
Frederic I. Winslow,
Committee on Library.

REPORT OF THE EXECUTIVE COMMITTEE OF THE SANITARY SECTION.

BOSTON, MASS., March 5, 1918.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year five meetings of the Section have been held, as follows:

March 7, 1917. — Annual meeting. In addition to reports of the various committees, Mr. Geo. W. Fuller talked on the question "What shall be the Limitation in the Pollution of Rain Waters so that they may be Safely Purified by Modern Water Treatment Plants." Forty-five present.

June 6. — Illustrated talk by Robert Spurr Weston, on "Biological Self-Purification of Coweeset River, Brockton, Mass." Twenty-two present.

November 1. — Talk by Major Glenn I. Jones, on "Precautions taken to Safeguard the Health of Workmen at Camp Devens." Thirty-seven present.

December 5. — Illustrated talk on "Sanitary Conditions of Swimming Pools," by Stephen DeM. Gage and S. K. Nason. Forty-five present.

January 2, 1918. — Discussion on "Subject of Sewer Pipe Joints," by J. Leslie Woodfall *et al.* Eighteen present. This meeting reported in the February JOURNAL.

An effort has been made this year to draw out a greater number of discussions at the meetings. We believe that much more can be done along this line than has thus far been accomplished, and that the results, if successful, will be of considerable benefit.

The meetings of the Section, as held in the Library, are less formal than when held in a larger room; and there is a greater tendency toward sociability, a feature which should be cultivated to an increased extent.

The ventilator installed during the past year has proven entirely satisfactory, thereby remedying one cause of discomfort. It is hoped that the difficulties with the projection screen can be overcome with equal success.

Three new members have been enrolled during the year, making the total membership 176.

HENRY A. VARNEY, *Acting Clerk.*

REPORT OF THE COMMITTEE ON SOCIAL ACTIVITIES.

BOSTON, MASS., March 20, 1918.

To the Boston Society of Civil Engineers:

There were included in the activities of the Society during the past year three excursions. The principal work of this committee has been to arouse an interest in these events and to assist in the details necessary for the comfort of those attending and for the success of the excursions.

The Field Day of the New England Water Works Association and the Boston Society of Civil Engineers was held at Norumbega Park, June 17, 1917. The program included a ball game between the two societies, dinner at the Park restaurant, meetings of the societies after the dinner, and the regular attractions of the park. The attendance was 151, and there were many ladies among the guests. The Boston Society won the ball game, the score being 20 to 4.

On December 19 there was an excursion to the Massachusetts Institute of Technology. Members and their guests were conducted by guides through the buildings, all assembling at the Hydraulic Laboratory in time for its inspection before dinner. Dinner was served at the Cafeteria, where 109 were seated. The regular meeting was held in the large lecture hall in the evening.

One hundred twenty-six members and guests visited the Squantum Destroyer Plant on February 20, 1918. Special cars from the Dudley Street Station were at the service of those in attendance, who were conducted over the plant in groups, by guides.

Respectfully submitted,

David A. Ambrose,
Chairman Committee on Social Activities.

Report of Committee on Run-Off.

Boston, March 20, 1918.

To the Boston Society of Civil Engineers:

The Committee on Run-Off, appointed December 20, 1916, has met eleven times, usually on the dates of Society meetings. It has discussed a number of questions affecting the accuracy of run-off measurements, particularly the following: Winter ratings; methods of measurement, and calendar year *versus* climatic year. The following subjects have also been given some attention, and it is hoped to discuss them more or less fully in the final report of the committee: Gage height observations; character of river; slope measurements; measurements at weirs and dams; velocity measurements; rating of current meters; current meter type characteristics; flood measurements; artificial control of flow (regulation); office method of computing and presenting data; relations of rainfall and run-off; length of records and effect on comparisons and analysis; use of snowfall data; evaporation, and New England precipitation.

The committee has found the amount of material so great that it can only report progress at the present time, and ask to be continued.

The value of the committee's work can be very much increased if some means can be found to reach other members of the Society who are interested in the same questions which the committee is studying. It is therefore requested that such members submit to the committee any discussions or suggestions which might help in this study.

At the December meeting of the Committee on Run-Off, the question of publishing run-off records by the calendar year instead of the climatic year was discussed, and a subcommittee was appointed with a twofold object:

First. To obtain the reasons why the Geological Survey changed from the calendar year to the climatic year.

Second. To find which method is preferred by the hydraulic engineers of New England.

In regard to the first object, the following letter, which was received from Mr. N. C. Grover, chief hydraulic engineer of the water resources branch of the U. S. Geological Survey, will explain itself.

> " The reasons for this action on the part of the Survey may be grouped under two heads: First, the preparation of the data for publication; and second, the use of the data.
>
> "*First:* It has been found to be in the interest of economy and accuracy to compute and prepare for publication the stream-flow data for the winter season as a whole. A break at the end of the calendar year leads to inconsistencies and inaccuracies of the most glaring type, as illustrated by the old records where the data were broken on December 31. These inaccuracies are largely avoided by the use of the climatic year and the computation at one time of the data for the whole period of ice.
>
> "*Second:* In many sections of the country, and especially in those sections where irrigation is practiced, the use of the data is best served by its division between the season of use and the season of replenishment. Of course, if the data are published on any other basis, they may be assembled by the user on the basis of a climatic year adapted to the particular region in which he is interested. However, for most portions of the United States the year beginning October 1 seems to be adapted to the requirements."

In regard to the second object, each member of this committee was communicated with and requested to furnish a list of names of hydraulic engineers from whom he thought information should be obtained. A circular letter was sent to each one of the engineers indicated. About 36 replies were received. Of those, 31 could be used; 17 preferred the calendar year, 10 preferred the climatic year, 2 had no preference, and 2 felt that neither the climatic nor the calendar year gave a proper division.

The committee suffered a serious loss when Lieutenant Pierce was called into active military service. His assistant, Mr. H. W. Fear, has been acting as secretary of the committee since his departure, and his successor as engineer of this district for the Geological Survey, Mr. O. W. Hartwell, is acting with the committee.

Respectfully submitted for the committee,

ARTHUR T. SAFFORD, *Chairman.*

ARTHUR T. SAFFORD, *Chairman*,
CHARLES H. PIERCE, *Secretary*,
HAROLD S. BOARDMAN,
X. HENRY GOODNOUGH,
RICHARD A. HALE,
GEORGE E. RUSSELL,
CHARLES W. SHERMAN,
HERBERT A. MOODY,
W. FRANK UHL,
JOSEPH F. WILBER,
DANA M. WOOD,
Committee on Run-Off.

REPORT OF THE EDITOR.

TO THE BOARD OF GOVERNMENT OF THE BOSTON SOCIETY OF CIVIL ENGINEERS:

Gentlemen, — The following is the Editor's report for the calendar year 1917. The customary 10 issues, of 1 250 copies each, comprising 24 papers and 7 memoirs of deceased members, have been published.

The total number of pages used was 787, and the net cost $1 997.44, or $2.54 per page, as against $1 883.81 or $2.19 per page in 1916.

The greater part of this higher apparent cost in 1917 is explained by the fact that the credit for advertisements is only for cash actually received, and does not include charges for some advertisements obtained in the latter part of the year. Actually, the amount of advertising carried at the end of the year was slightly greater than at the beginning of the year, and the charges against advertisers was about the same in both years.

Early in the year the President expressed some hope that the cost of the JOURNAL might be reduced by a material increase in the number of advertisements. This result has not been realized, although in spite of a considerable number of withdrawals the amount of space carried, as just stated, has been maintained.

The Editor has done a considerable amount of work along these lines, and a large number of firms have been canvassed. Only in special cases has much encouragement been received. When the published papers have a direct appeal to a certain class of advertisers, interest can sometimes be aroused. Both the paper on Concrete Piles and the lecture on Camp Devens were the direct means of obtaining advertisements.

In a strictly professional journal, however, relations of this kind are of course only incidental, and cannot be developed for the sole purpose of increasing advertisements.

A considerable saving is possible by keeping the number of illustrations within moderate limits. At the present time, one full page half-tone costs about five dollars. It might also be desirable to discontinue the practice of making few reprints for authors, at a saving of some $150 per year.

A considerable saving in 1917 has been made possible by the coöperation of authors who have met the expense of a part or all of the illustrations in their papers, because they desired to secure the plates for other uses.

The appended table gives the details of costs and pages printed.

Respectfully submitted,

W. L. BUTCHER, *Editor.*

1917 JOURNAL.

Month.	PAGES OF				NO. OF		COST OF							
	Papers.	Proc.	Index.	Adv.	In-serts	Cuts.	Papers, Proc. and Index.*	Cuts.	Advts.	Reprints.	Postage, Wrapping and Mailing.	Editing.	Incident-als.	Copyright.
Jan.	65	13		16¼		23	$246.39	$31.85	$16.31	$29.50	$21.65		$3.26	$10.00
Feb.	36	14		16⅛		4	170.56	5.70	21.05	14.57	17.35		1.07	
Mar.	42	16		16		7	184.29	17.50	15.80	16.07	16.56		0.96	
Apr.	63	30		16		43	283.95	90.46	15.80	34.00	24.81		0.23	
May	36	14		16⅛		11	161.82	29.00	21.75	20.50	17.69			
June	22	12		16⅛			134.45		16.90	22.50	24.10			
Sept.	32	14		16⅓		1	170.50	4.17	21.48	21.00	20.97			
Oct.	46	12		16⅓		9	193.24	14.72	20.75	18.50	18.73			
Nov.	54	10		17⅝		25	233.85	80.10	27.65		19.19			
Dec.	54	12	10	16⅝		1	236.85	3.20	18.80	36.00	30.58			
												$450.00	$5.52	$10.00
Total	450	147	10	163½†		124	$2 015.90	$276.70	$196.29	$212.64	$211.63			

Total gross cost		$3 378.68
Subscriptions	$34.68	
Sale of JOURNALS	32.00	
Sale of reprints	23.63	
Author's payments for illustrations	176.93	
Receipts from advertisements	1 114.00	1 381.24
Net cost		$1 997.44

---

* Including stock for advertising pages.

† One hundred eighty pages used; not set solid.

APPLICATIONS FOR MEMBERSHIP.

[April 12, 1918.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Gauthier, Almon Isaac, Groton, Mass. (Age 30, b. Cornwall, Ont.) Graduate of Cornwall High School, regular three-year course and two-year college preparatory course. From September, 1906, to May, 1907, rodman with Locks and Canals Co., Lowell, Mass.; from June to December, 1907, rodman with B. M. R. R., Boston; from April to December, 1908, rodman on sewer and water works and transitman on street work with City of Lowell, Mass.; from April, 1909, to June, 1917, with B. & M. R. R., serving as rodman, transitman and assistant engineer on building construction, grade crossing elimination, etc., until October, 1911; from October, 1911, to June, 1914, as division foreman of bridges and buildings, W. N. & P. Division, Nashua, N. H.; from July, 1914, to January, 1915, as general foreman in charge of maintenance of bridges and buildings, Terminal Division, Boston; and for remainder of time as supervisor of bridges and buildings in charge of maintenance, Concord, N. H.; in June, 1917, enlisted in 14th Engineers (railway), and is now master engineer (senior grade), serving in France with that regiment. Refers to C. R. Chevalier, S. P. Coffin, A. B. Corthell, J. J. Rourke and F. C. Shepherd.

Haley, Frederic William, Haverhill, Mass. (Age 24, b. Haverhill, Mass.) From May, 1912, to April, 1916, with J. T. Desmond, C.E., Haverhill; is now assistant engineer with F. A. Barbour, in whose employ he has been since April, 1916. Refers to F. A. Barbour, H. H. Chase, B. R. Felton, L. C. Lawton, J. E. Palmer and R. D. Hood.

Steward, Harry Matthew, Medford, Mass. (Age 45, b. Skowhegan, Me.) Graduate of Lynn, Mass., Classical High School, 1892, course including special work in mathematics and surveying during last two years; studied civil and bridge engineering with International Correspondence School. From August, 1892, to 1899, rodman, transitman and assistant engineer with B. & M. R. R., engineering department; early in 1899 was transferred to maintenance of way department as assistant to road master of Southern Division, and on March 1, 1901, was appointed assistant road master in charge of Central Massachusetts branch of Southern Division, B. &. M. R. R.; from October, 1903, to date, with Boston Elevated Railway Co., having served as road master of rapid transit lines until March 1, 1912, when he was appointed chief engineer of maintenance of way department, which position he now holds; since February 1, 1918, all of the engineering of the company has been under his direction. Refers to J. E. Carty, F. H. Fay, C. T. Fernald, H. W. Hayes, H. C. Hartwell, F. W. Hodgdon, L. C. Lawton, A. L. Plimpton, J. H. Rourke, L. K. Rourke, J. P. Snow, J. H. Sullivan, G. F. Swain and S. E. Tinkham.

ROLL OF HONOR.*

Atwood, Joshua. Captain, Infantry, National Army, Headquarters Northeastern Dept , Boston, Mass.

Babbitt, John H. 2d Lieutenant, C. A. C.

Balch, William H. Captain, E. O. R. C., Am. Ex. Force, France.

Beard, Cornelius. 1st Lieutenant, Company A, 101st Engrs., Am. Ex. Force, France.

Bresth, Alexander.

Brown, H. Whittemore. 2d Lieutenant, E. O. R. C., 301st Engrs., Camp Devens, Mass.

Brown, William Augustine. Div. 4, Sec. 3, U. S. Naval Training Station, Bumkin Island, Mass.

† Bryant, Chauncey D. 1st-class Private, 101st Engrs., Am. Ex. Force.

Bunker, Page S. Major, Ordnance Dept., U. S. N. A., Augusta Arsenal, Augusta, Ga.

Burleigh, Willard G. Corporal, Company E, 25th Engrs., Camp Devens, Mass.

Bussey, Byron C. 2d Lieutenant, E. O. R. C., Officers' Training Camp, Washington, D. C.

---

* This list is made up from replies to a circular sent out to members of the Society, and from various other sources. That future lists may be more accurate and complete, members are requested to call the attention of the Secretary to any inaccuracies or omissions.

† Died in France.

CLAPP, WILFRED A. Q. M. C.

CLARKSON, EDWARD H., Jr. Sanitary Engineer, American Field Ambulance.

COBURN, WILLIAM H. 1st Lieutenant, Field Supply Section, Gas Defense Service, New Interior Bldg., Washington, D. C.

CRAIGUE, JOSEPH S. Captain, Engrs., U. S. R., Am. Ex. Force, France.

CROSS, RALPH U. 1st-class Sergeant, Q. M. C., U. S. A., Headquarters Northeastern Dept., Boston, Mass.

CURTIS, GREELY S. Lieutenant (j. g.), Naval Militia, Mass.

DASHPER, FREDERICK C. With British Army.

DAVIS, HAROLD F. Supply Sergeant, 6th Reg't, Company A, Mass. Infantry, Am. Ex. Force, France.

DELANO, RAY O. Sergeant, Company B, 301st Engrs., Camp Devens, Mass.

DEMERRITT, ROBERT E. 2d Lieutenant, C. A. C., U. S. A., Fort Monroe, Va.

DEMING, GUY S. 1st Lieutenant, Signal Corps, Construction Div., Aviation Section, 49 South Maple Avenue, East Orange, N. J.

DRUMMOND, WILLIAM W. Captain, Engrs., U. S. R., Camp Lee, Va.

DURHAM, HENRY W. Captain, Engrs., R. C., 20th Engrs., Camp American Univ., Washington, D. C.

EDDY, HARRISON P., Jr. Assistant Naval Constructor, U. S. N. R. F., U. S. Navy Yard, Norfolk, Va.

ELKINS, CLAYTON R. Lieutenant, Public Works Dept., Navy Yard, Norfolk, Va.

ELLSWORTH, SAMUEL M. Company I, 3d Officers' Training Camp, Camp Upton, Long Island, N. Y.

ENEBUSKE, CARL C. 55th C. A. C.

FERNALD, GORDON H. 1st Lieutenant, E. O. R. C., 304th Engrs., Accotuik, Va.

FOOTE, FRANCIS C. Lieutenant, 303d Engrs., E. O. R. C.

FRENCH, HEYWOOD S. Major, Q. M. C., National Army, 2521 University Place, Washington, D. C.

GERRISH, HERBERT T. 1st Lieutenant, Engr. R. C., E. R. O. T. C., Camp Lee, Va.

GIBLIN, JOHN F. A. 1st Lieutenant, 101st Engrs., Am. Ex. Force, France.

GOW, CHARLES R. Major, Q. M. C., National Army.

GUNBY, FRANK M. Lieutenant Colonel, Cantonment Div., Q. M. C., U. S. R., 1156 15th Street, Washington, D. C.

GUPPY, BENJAMIN W. Major, 14th Engrs., Am. Ex. Force, France.

HALE, RICHARD K. Lieutenant-Colonel, 101st Field Artillery, Am. Ex. Force, France.

HANF, FRANK S. 2d Lieutenant, Engrs., U. S. R., 2d Battalion, 2d U. S. Engrs., Am. Ex. Force, France.

HANNAH, THOMAS E. 1st Lieutenant, C. A. C., Fort Monroe, Va.

HARTY, JOHN J., Jr. Captain, Ordnance Dept., U. S. R., Springfield Armory, Springfield, Mass.

HASTIE, FRANK B. 2d Lieut., Engr. Corps, U. S. A.

Hobson, George F. Captain 305th Engrs., Camp Lee, Petersburg, Va.

Hubbard, Carl P. Sergeant, Company D, 11th Engrs. (Ry.), Am. Ex. Force, France.

Kendall, Theodore R. 1st Lieut., Sanitary Corps, National Army.

Kimball, Herbert S. Captain, Ordnance Dept. (Technical Section), Officers' Reserve Corps.

Leonard, Joseph F. A. 2d Lieutenant, Engrs, U. S. R., Officer in Charge, Engr. Sub-Depot; Commanding Engr., Depot Detachment 421, Camp Wadsworth, Spartanburg, S. C.

Lohmeyer, William, Jr. 2d Lieutenant, Corps of Engrs., U. S. A., Barrack 47, McClellan Avenue, Fort Leavenworth, Kan.

Loud, Ralph W. Private, National Army.

Luther, Howard B. Lieutenant (j. g.), U. S. N. R. F., 1707 H Street, N. W., Washington, D. C.

Mattson, William R. 1st Lieutenant, Company E, 101st Engrs., Am. Ex. Force, France.

Monaghan, James F. Captain, Ord. R. C., U. S. A., 1330 F Street N. W., Washington, D. C.

Moore, Lewis E. Captain, E. O. R. C., Am. Ex. Force, France.

Nash, Philip C. 1st Lieutenant, E. O. R. C., U. S. A., Washington Barracks, Washington, D. C.

Nolan, Conrad. Corporal, Battery D, 301st Field Artillery, Camp Devens, Mass.

Ober, Arthur J. Major, E. O. R. C.

Osborn, John F. Captain, Company B, 101st Engrs., Am. Ex. Force, France.

Pierce, Charles H. 1st Lieutenant, Engrs., U. S. R., 7th Company, Engr. Reserve Officers' Training Camp, Camp Lee, Va.

Rand, Robert. Lieutenant (j. g.), U. S. N. R. F., Communication Office, Bldg. 24, Navy Yard, Boston, Mass.

Reed, Leslie P. 2d Lieutenant, U. S. Signal Reserve Corps, Engr. Section, Room 356, Union Station, Washington, D. C.

Richardson, Edward B. Captain, Battery A, 101st Field Artillery, Am. Ex. Force, France.

Richmond, Carl G. 1st Lieutenant, 602d Engrs., Camp A. A. Humphreys, Va.

Saville, Thorndike. 1st Lieutenant, Signal Corps, U. S. A., Construction of Water Supply and Sewerage Systems, Supply Div., Langley Field, Hampton, Va.

Sawyer, George S. Sergeant, Company A, 504th Engrs. Battalion, Camp Devens, Mass.

Shaw, Arthur L. Captain, Engr. R. C., 301st Engrs., Camp Devens, Mass.

Smith, William H. Lieutenant, Asst. C. E., C. E. C., U. S. N.

Snow, Leslie W. 1st Lieutenant, Gun Div., Office of Chief of Ordnance, 1330 F Street, Washington, D. C.

SOUTAR, GEORGE P. Private, 17th Company, 151st Depot Brigade, on detached service studying meteorology at U. S. Weather Bureau, Boston, Mass.

SPEAR, WALTER E. Major, Q. M. R. C., Camp Upton, Long Island, N. Y.

STENBERG, THORNTON R. 2d Lieutenant, 301st Infantry, on detached service at School of Military Aeronautics, University of Texas, Austin, Tex.

STROUT, HENRY E., Jr. 1st Lieutenant, C. E., U. S. A., 319th Engrs., Camp Fremont, Cal.

THOMPSON, SANFORD E. Major, Progress Section, Office of Chief of Ordnance, Washington, D. C.

TOSI, JOSEPH A. Private, Company 2, 3d Officers' Training Camp, Camp Devens, Mass.

TUCKER, HERMAN F. Ensign, U. S. N. R. F., Seattle, Wash.

WADE, CLIFFORD L. 1st Lieutenant, E. O. R. C., care U. S. Geological Survey, Washington, D. C.

WADSWORTH, GEORGE R. Major, Aviation Section Signal Corps, U. S. A., Chief Engr., Naval Aircraft Factory, Navy Yard, Philadelphia, Pa.

WARING, CHARLES T. Major, Supply Div., Signal Corps, Langley Field, Hampton, Va.

WEBB, DEWITT C. Lieutenant Commander, Public Works Office, U. S. Navy Yard, Philadelphia, Pa.

WELLS, EDWARD P. Cadet, U. S. A. School of Military Aeronautics, Ithaca, N. Y.

WENTWORTH, JOHN P. Captain, Sanitary Corps, National Army, Div. Headquarters, Camp Lee, Va.

WESTON, ARTHUR D. Lieutenant, 26th Engrs., Camp Dix, N. J.

WHITMAN, RALPH, Lieutenant Commander, U. S. Navy, care U. S. Military Gov't, San Domingo, R. D., via Postmaster, N. Y.

WHITNEY, ORVILLE J. Major, Auto Aircraft Machine Gun Battalion, Camp Wadsworth, N. Y.

WHITNEY, RALPH E. 1st Lieutenant, Sanitary Corps, National Army, Surgeon General's Office, Washington, D. C.

WIGGIN, THOMAS H. Captain, E. O. R. C., Am. Ex. Force, France.

WOOD, FREDERIC J. Major, Engrs., U. S. R., Curtis Bay Ordnance Depot, South Baltimore, Md.

WOOD, LEONARD P. Captain, E. O. R. C., Am. Ex. Force, France.

WORCESTER, ROBERT J. H. 1st Lieutenant, Inf. R. C., Company 12, 3d Battalion, Depot Brigade, Camp Devens, Mass.

LIST OF MEMBERS.

ADDITIONS.

KILLION, LOUIS J.	45 Winthrop St., Roxbury, Mass.
SAUER, FRED E., Jr.	50 Norwood St., Everett, Mass.

CHANGES OF ADDRESS.

Atwood, Thomas C. ....U. S. Navy Dept., Atlantic, Mass.
Blanchard, Arthur H. ....Broadway and 117th St., New York City, N. Y.
Buckley, William J. ....65 Winter St., Montello, Mass.
Clark, Charles S. ....Room 754, 141 Milk St., Boston, Mass.
Connolly, S. John ....201 Devonshire St., Boston, Mass.
Curtis, Ralph E. ....15 Allen St., West Roxbury, Mass.
Eberhard, Walter C. ....76 Morris St., Dover, N. J.
Ferguson, John N.,
Mass. Comm. on Waterways and Public Lands, Dry Dock, Boston, Mass.
Forbes, Fred B. ....541 State House, Boston, Mass.
Ford, Arthur L. ....12 Marshall St., Malden, Mass.
Fuller, Andrew D. ....22 Kent St., Somerville, Mass.
Fuller, Frank L. ....201 Washington St., Wellesley, Mass.
Grover, Nathan C. ....1442 Belmont St. N. W., Washington, D. C.
Harkness, Arthur F. ....541 State House, Boston, Mass.
Horne, Harold W. ....Miami Conservancy District, Dayton, Ohio
Hunter, Harry G. ....615 New Birks Bldg., Montreal, Canada
Hutchison, Richard ....49 Federal St., Boston, Mass.
Manley, Henry, Jr. ....819 Gravesend Ave., Brooklyn, N. Y.
Morrill, Frank P.,
13 Rosewood Terrace, Tompkinsville, Staten Island, N. Y.
Morrison, John W. ....Room 203, 60 Congress St., Boston, Mass.
Nelson, William ....41 Magazine St., Cambridge, Mass.
O'Brien, James A. ....City Hall, Chelsea, Mass.
Pike, Waldo F.,
care Fay, Spofford & Thorndike, 308 Boylston St., Boston, Mass.
Pratt, Daniel W. ....11 Willow St., Winchester, Mass.
Proctor, Fred W. ....Hoosac St., North Adams, Mass.
Rockwood, Edward F. ....147 Milk St., Boston, Mass.
Savage, John Dana ....1864 Northampton St., Holyoke, Mass.
Sears, Calvin C. ....3 Bryan Ave., Branford, Conn.
Smith, Sidney ....5347 Baltimore Ave., Philadelphia, Pa.
Stearns, Ralph H. ....1 Ashburton Place, Boston, Mass.
Sutton, David ....15 Ashmont Road, Waban, Mass.
Thomas, John F., Care Charles T. Main, 201 Devonshire St., Boston, Mass.
Tosi, Joseph A., Care Charles A. Tosi, 152 Franklin St., New York, N. Y.
Van der Pyl, Edward ....9 Clifton St., Worcester, Mass.
Walker, Frank B. ....245 State St., Boston, Mass.
Warren, Henry E. ....149 Meridian St., East Boston, Mass.

DEATHS.

Aspinwall, Thomas ....March 2, 1918.

RESIGNATIONS.

(In effect March 20, 1918.)

Ackerson, Herbert N.
Burr, Thomas S.
Caldwell, Frederick A.
Davis, Leonard H.
Drowne, Henry B.
Durant, William B.
Foller, Samuel J.
Hall, Frank E.
Hoxie, Arthur E.
Kelley, Mark E.
Lanphear, Roy S.
Marvell, Edward I.
Mead, Royal L.
Morrill, Fred W.
Nash, S. Aubin.
Phillips, Henry A.
Sarle, O. Perry.
Saville, Caleb Mills
Skinner, Fenwick F.
Smith, Melvin B.
Stocker, Malcolm G.
Von Loesecke, Sidney S.
Whitney, Walter C.

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of men *available*, giving in each case detailed information in relation thereto.

Men Available.

421. Age 49. Has had wide experience in heavy construction on tunnels, dams, canals, pipe lines and water works; would prefer position along these lines, although experience also covers sewers, pavements, highways and steel bridge erection. Would accept salary of $150 per month, with good opportunity for advancement.

LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Annual Report of Director of Geological Survey for 1916–17.

Antimonial Silver-Lead Veins of Arabia District, Nevada. Adolph Knopf.

Borax in 1916. Charles G. Yale and Hoyt S. Gale.

Cement in 1916. Ernest F. Burchard.

Chemical Analyses of Igneous Rocks. Henry Stephens Washington.

Combustion of Coal and Design of Furnaces. Henry Kreisinger and others.

Compressibility of Natural Gas and Its Constituents, with Analyses of Natural Gas from Thirty-one Cities in United States. G. A. Burrell and I. W. Robertson.

Control of Hookworm Infection at Deep Gold Mines of Mother Lode, California. Dr. James G. Cumming and Joseph H. White.

Dunkleberg Mining District, Granite County, Montana. J. T. Pardee.

Effect of Low-Temperature Oxidation on Hydrogen in Coal and Change in Weight of Coal on Drying. S. H. Katz and H. C. Porter.

Five Ways of Saving Fuel in Heating Houses. Henry Kreisinger.

Fluorspar and Cryolite in 1916. Ernest F. Burchard.

Gold, Silver, Copper, Lead, and Zinc in Nevada in 1916. V. C. Heikes.

Gold, Silver, Copper, Lead, and Zinc in New Mexico and Texas in 1916. Charles W. Henderson.

Gold Placers of Tolovana District, Alaska. J. B. Mertie, Jr.

Louisiana Clays. George Charlton Matson.

Possibilities for Manganese Ore on Certain Undeveloped Tracts in Shenandoah Valley, Virginia. D. F. Hewett and others.

Stratigraphy in Southwestern Maine and Southeastern New Hampshire. Frank J. Katz.

Tin Resources of Kings Mountain District, North Carolina and South Carolina. Arthur Keith and D. B. Sterrett.

Vapor Pressures of Various Compounds at Low Temperatures. G. A. Burrell and I. W. Robertson.

Water-Supply Papers 406, 418, 424, 430, 434, 445.

State Reports.

Massachusetts. Proceedings of Fifth Annual City and Town Planning Conference of Massachusetts Planning Boards, 1917; Lowell Homestead Project.

Michigan. Annual Report of State Board of Health for 1914–15.

Ohio. Technical Reports of Miami Conservancy District as follows: Miami Valley and 1913 Flood, by Arthur E. Morgan; Theory of Hydraulic Jump and Backwater Curves, by Sherman M. Woodward, and Hydraulic Jump as Means of Dissipating Energy, by Ross M. Riegel and John C. Beebe; Storm Rainfall of Eastern United States, by Engineering Staff of District.

Municipal Reports.

Belmont, Mass. Annual Report of Water Commissioners for 1917.

Cambridge, Mass. Annual Report of Water Board for 1916–17.

Detroit, Mich. Annual Report of Water Commissioners for 1916–17.

Laconia, N. H. Annual Reports of Board of Public Works for 1917.

Melrose, Mass. Annual Report of Park Commissioners for 1917.

Northampton, Mass. Annual Report of Water Commissioners for 1917.

Plymouth, Mass. Annual Report of Water Commissioners for 1917.

Providence, R. I. Annual Reports of Water Supply Board for 1915–16 and for 1917.

Rutland, Vt. Annual Report for 1917.

Miscellaneous.

American Institute of Mining Engineers: Transactions for 1917, Vol. LVI.

American Society of Civil Engineers: Transactions for 1917, Vol. LXXXI.

Canada, Department of Interior: Catalogue of Stars for Latitude Observations on Dominion Lands Surveys.

Canada, Department of Mines: Production of Copper, Gold, Lead, Nickel, Silver, Zinc and Other Metals in Canada during 1916; Iron Ore Occurrences in Canada, Vol. II, with maps, by E. Lindeman and L. L. Bolton.

Cement-Gun Co., Inc.: Bulletins.

Diamond Power Specialty Co.: Diamond Soot Blowers for Water Tube Boilers.

Navigation. G. L. Hosmer. Gift of author.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.* — The new 3,000,000-gal. centrifugal pumping unit at the Arlington Pumping Station has been erected, and is nearly ready for operation.

METROPOLITAN PARK COMMISSION. — *Old Colony Parkway.* — Construction of a temporary bridge across the Neponset River between Boston and Quincy is in progress; also construction of double siphon for water and gas under new channel.

BOSTON TRANSIT COMMISSION. — Work is progressing on the Surface Station near Massachusetts Avenue for the transfer of passengers between surface and subway cars.

The following repaving in South Boston where the Dorchester Tunnel has been constructed will soon be begun:

Dorchester Avenue on a concrete base between West Second

Street and Old Colony Avenue, and between Humboldt Place and the southerly side of Andrew Square, and Boston Street on a gravel base from Andrew Square to the vicinity of Ralston Street.

New York, New Haven & Hartford R.R. Co. — *South Boston Cut Improvement.* — Enlargement of South Boston Cut to Boston Freight Terminal, to accommodate four tracks instead of two, and reconstruction of eleven overhead highway bridges, so as to span four tracks instead of two, progressing. Excavation by steam shovel has advanced from westerly end of cut into Broadway. Bridge abutments being constructed at West Sixth Street, West Fifth Street, Gold and Silver streets. Permanent pumping plant being constructed at Dorchester Avenue.

Vol. V APRIL, 1918 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

ADDRESS AT THE ANNUAL MEETING.

By George C. Whipple, President Boston Society of Civil Engineers.

(March 20, 1918.)

The Engineer in the New Democracy.

In complying with the prescribed obligation of the retiring president to deliver a valedictory address, I cannot in these days of war speak of anything else than our own place in the great struggle and in what will come after. I have accordingly taken for my subject, *The Engineer as a Social Force in the New Democracy.*

The United States has been at war nearly a year. The victory is not yet won. But we are going to win it, — that much is certain. We are going to win the war because we believe the cause of liberty is worth fighting and dying for, and because we have men enough who are willing to fight and die. We are going to win because American resources directed by American engineers, when added to the forces of our allies, will turn the scale of military power in our favor. Victory will come; but what will come after the victory? The world will be made safe for democracy; but how is democracy to be made safe for the world?

It is hard to look ahead, these days, and very hard to see clearly, but never was foresight so much needed as now. Engineers, as a class, have been trained to look ahead. To draw a plan is to look ahead, — and the planners of our railroads, our water supplies, our power distribution plants have seldom failed to exercise good judgment in forecasting the future.

In recent years our forecasting has been largely on a mathematical basis, — it has been a quantitative problem; but now the problem is different. Unless signs fail there is going to be a social reconstruction of the world. In fact, this is now going on before our very eyes if we will but see. Ferrero said that when Rome fell the Romans at the time never knew that it was falling.

The engineer must therefore extend his thought far beyond his usual bounds, because the new problem is not physical and mathematical, but rather political and ethical. The engineer must join with the members of the other professions, and what is more important he must join with the workers themselves, in laying plans for the new democracy and the new social order which seems destined to come not only in Russia but in England and Germany, in America, and, we may well say, throughout the civilized world. Because of his experience in looking ahead, because of his position as an intermediary between owner and contractor, between capital and labor, because of his habit of doing things in large ways, the engineer seems destined to play an important part in the coming reconstruction. The engineer's prominence in the war will give him added opportunities after the war is over. To the victors belong the responsibilities, not the spoils.

It is hard to tell even in generalities what is going to happen, but some things seem reasonably certain. Autocracy is going to give way to democracy in all of the great countries of the world. This means that to a greater extent than ever before the political power will be in the hands of the working people, that persons of limited education will have more direct control than now of the policies and actions of their governments. The relations between capital and labor are going to change; the wage system will be modified and may even give way to some other system of payment based on the idea of profit sharing. The great fortunes and the great holdings of land are going to be subdivided. The government may control not only the railroads, but other public utilities, as well as the basic resources of nature. We are going to live under new conditions, and, whatever our preconceived ideas, we must adapt ourselves to the new order. The changes will not come in a day, but they will come sooner than any of us would have predicted a year or two ago. Indeed, they have already begun.

Efficiency and Democracy. — Democracies, considered as nations, are inefficient. History tells us that. Yet we need not go back of the present war to see it. An army is more efficient than a mob; an organized nation is more efficient than one not well organized; industry and transportation organized under the large corporation plan are more efficient than under the small unit plan. Organization and efficiency seem to be inseparable terms.

Where efficiency exists, the ruling power is almost invariably at the top and its branches extend downwards, ever dividing as in the vagarious organization-charts which our bureaus of municipal research delight to draw. But what is meant by efficiency? Broadly speaking, it is doing much with little effort; it is getting out of a machine in one form the energy put into it in another form; it is making the most of the apparatus, the best use of time, accomplishing a result in the best way. In any measure of machine efficiency the thought is centered primarily on the result, secondarily on the power applied and the raw material consumed, lastly on the effect of the process on the machine itself. Under autocracy we see this idea illustrated in human society. The upper ruling power has a result in mind, — it may be benevolent or selfish, — the nation is organized to secure that result, all the units of the nation are required to work to that end, and the effect of the process on the constituent human units is regarded as a minor affair. The United States is temporarily and of necessity in this condition to-day. The object in view is to win the war; we are voluntarily organizing ourselves from the top down, to bring about this result; we are trying to make the most of our powers and resources; and we don't care what happens to any one of us.

But in times of peace conditions are different. Then the legitimate object of government is to provide conditions favor-able for the life of each and every individual in the nation. The purpose of the nation is not ulterior, but interior. Efficiency takes on a new meaning. No longer is it a comparison between applied energy and material result, but a threefold comparison between process, machine and product, with the effect of the process on the machine as the controlling thought. In mechanics we have no single word to express this idea, although we do speak of the "life of the plant," of "friction," of "depreciation." In human society we have already some very old and very adequate words, — health, comfort, happiness and contentment of the people, — sometimes summed up in the word "welfare." In autocracy, efficiency means a comparison between work and result; in democracy, it should mean rather a comparison between work and welfare. Such relations might be called *beneficient*, to use an obsolete word with a somewhat new meaning, — a word not to be confounded with beneficent or benevolent, both of which contain the element of charity. *Beneficiency* is not that; it is efficiency plus humanity. In this country, as in most civilized countries, we have striven for efficiency, and it is partly for this reason that the laboring people claim that we are an economic autocracy. It is well known that the movement for efficiency has not been received in a friendly spirit by the laboring people. Why? Because they believe just this, — that efficiency considers the work and the product and leaves them out. Beneficiency would mean placing the product and the effect on the worker in equal regard. The world is demanding that this change be made.

The present war is expanding in a most remarkable and significant manner. At the beginning it was regarded as a contest of nations; then it was seen to be a contest between national autocracy and national democracy; now it is becoming something still broader, — a contest between social autocracy and social democracy the world over. We saw this first in Russia, and we viewed it with alarm; but when we see it spread over Austria and Germany we do not object, because it will tend to disintegrate our enemies. Do we realize that the same contest is going on in England and America? And when it comes, as come it will, how are we going to receive it? Our future tranquillity depends much upon the answer. Are we going to hold to the old idea of efficiency, and make the product of the nation the object of our work, or are we going to take the new view of beneficiency and place the welfare of the worker on an equality with his product, bending our present organizations to that point of view, lest they be broken altogether?

I hate the German nation as exemplified by the Prussian autocracy, with what, I hope is a righteous hatred, and I am confident that Germany will be beaten and her present rulers blotted out; but I do not believe that a mere crushing of the German military power will bring peace to the earth. I believe that a readjustment of political and social conditions throughout the world is inevitable, and that peace and tranquillity will not come until these great questions are settled. We talk with disdain about the revolutionists of Russia, and the word "Bolshevic" has come to have a sinister meaning. But the ignorant, well-meaning Russian people are honestly seeking a way to build up a new democracy, social, political and religious, and we will do well to study their efforts. With their lack of knowledge and experience, with a dark background of brutal repression, they are making grievous work of it. We, with universal education, with more than a century of liberty and free government as a background, ought to do better. The Russians have the spirit but lack the education; we have the education, — do we lack the spirit?

Following the war the great problems of the day will be social problems, and the engineer must play his part in them. As the great exponent of efficiency, it will be one of his first tasks to alter the meaning of the term so that it will of necessity include a higher regard for the worker, — for his health, for his comfort and for his general welfare.

Conceptions of Democracy. — While we of America believe in democracy, there have been many able, honest, doubters among the world's great thinkers. If one wishes to appreciate this let him read Lecky's "Democracy and Liberty." In looking forward to a wider democracy, coextensive with civilization, it is important to consider what sort of democracy will be most beneficient. The first step in this study is to see in what respects people are thinking and acting along wrong lines. Professor Swain summarized these admirably in his presidential address before the American Society of Civil Engineers, at Ottawa, in 1913 (Trans. Am. Soc. C. E., LXXVI, 1112–1147), and I cannot do better than repeat here some of the things which he then said.

First of all, "*There is a tendency to consider that all men are equal in all respects*," an idea so obviously untrue that it ought not to need refutation. Men and women are different from each other, and these differences must be recognized in a democracy. With equal rights before the law, with equal rights and as far as possible equal opportunities to develop, with equal rights to the great essentials of human welfare, with equal rights to be judged according to worth, it yet remains that there are differences in people which cannot and ought not to be blotted out, but which on the other hand ought to be made the basis of penalty and reward. The rewards should not be equal; the ten-talent man should receive more than the one-talent man. In some way or other, I cannot say how, a man's reward, whether it be for the work of his hands, his head or his heart, should bear a reasonable relation to what he contributes to the common good.

Second, "*There is a tendency to disregard authority, to consider that one man's opinion is as good as that of any other, — a condition which leads to intellectual arrogance, dogmatism and lawlessness*." Superabundance of printed matter has encouraged this, while the headline habit has led to loose thinking, to the absorption of undigested fragments, and to the loss of the critical faculty. The daily newspaper is doing much to bring about intellectual equality in man; it raises the level of the uneducated by enabling him to learn about science and literature and affairs of state, while it lowers the level of the intelligent by feeding him on Buster Browns and Krazy Kats. In the daily press the opinion of the experienced man who really knows what he writes about is placed on the same level as that of the cub reporter who cares more for his story than for the truth.

Third, "*There is a disregard of experience, a tendency to consider any man good for any job.*" This is most glaring in the political world. We choose our executives by popular vote, without regard to special experience or training; we even talk about training a city manager in a technical school. Do we not know that a well-ripened city engineer is the man best fitted to be a city manager, — that judgment comes only with experience? Why do reform governments so often fail? Because success depends not only upon honesty but upon knowledge and experience. Why do reactionary governments so often succeed? Because extravagance and corruption are not synonymous terms, and because the "old line" government is often beneficient rather than efficient, thereby getting better results from the employees. We must not lose sight of the fact, however, that corruption and extravagance too often go together, and that a beneficient government may become far too benevolent to its office holders, with efficiency left to take care of itself.

Fourth, "*There is a tendency to relax discipline.*" This was the first effect of the Russian revolution. The soldiers refused to obey or even to salute their officers. But we do not need to go to Russia for illustrations. We see it in our schools, in our homes, in our laws, in our social relations. Professor Swain says, "We are victims of an exaggerated humanity and a decay of discipline. We fail to recognize that a prescription often needed, instead of condoling, kind words, sympathy and self-sacrifice, is the prompt and energetic application of the toe of the boot to the lower end of the spinal column."

Fifth, "*There is a tendency to laud innovations, to discredit the old and exalt the new,*" — a tendency which springs perhaps from the rapid progress of science and inventions.

Sixth, increase of wealth has led to luxury, extravagance, ostentation and waste.

Seventh, increasing altruism is perhaps causing the survival of the unfit and hence a tendency to the deterioration of the race.

These seven accusations of democratic tendencies are worthy of most serious thought. Different people will accept them in varying proportions, but it must be admitted that there is truth in each one.

What, then, is democracy? It was never defined better than by Lincoln, — "A government of the people, by the people, for the people." The United States lives by these words to-day. Are we about to apply the same formula to public utilities, to business, to industry? It looks so. The workers are demanding a share in the control of their work. They will get it, and I believe they ought to get it. But Lincoln's formula does not say that all men are equal, that we should disregard experience and authority, or that we should relax discipline and abolish organization, or that service should be unrewarded and neglect of duty go unpunished. It is just as important for the workers to study their Lincoln — our Great Labor President — as it is for the men who manage business to study what he said and did.

Work and Rewards. — The great contest will, as it always has, center around the problem of rewards. Few will deny that to-day rewards are disproportionate to service rendered the community in many of the walks of life. It has seemed to me that for many years the unskilled laborer, the common workman, has not received his fair share of the satisfactions of life. He has not been happy in his work, and if a man does not find happiness in his work he will not be contented, because a large part of every one's life is given up to work. The change from the outdoor life of the farm to the indoor life of the factory, the extreme subdivision of labor by which a man or a woman does but one thing in a most monotonous way is largely responsible. The mind cannot get satisfaction out of quantitative work, out of so-called efficient labor, even though the money in the pay envelope increases. One great problem, therefore, is to find a way to make hard, routine work less monotonous, more enjoyable, more healthful. We cannot, of course, get away from work or from hard work, if we try; there must also be self-sacrificing work. We can, however, improve working places with respect to hygienic and attractive conditions, and we can improve work with respect to hours and rest periods and to permanency of occupation. But we must also have efficient work, and this means better planning of details.

To establish a uniform length of working day is wholly illogical. The human machine should be operated at its maximum beneficiency, — at that rate at which it runs best for the machine and for the product, and for such intervals of time as are best for the product and for the machine. For hard, monotonous work there should be short days or days with broken periods, just as an army is rested on the march; for varied work the days may well be longer. There is opportunity here for the physiologists and psychologists to study and give advice. We can also hold the laborer in greater respect and provide rewards according to his ability, experience and faithfulness. The coal shortage and the food shortage have emphasized the dependence of human society upon common labor.

It has also seemed to me that the laborer of to-day does not get a fair opportunity to build a home, and next to work, perhaps even more than work, home life determines contentment. The first physical requisite of a home is shelter, family isolation, and a reasonable amount of individual privacy. Homes begin to vanish when cities become congested. Home life in an apartment, whether it be in the north end of Boston or in the Back Bay, tends to shrivel and disappear. A colossal blunder which civilization made in the nineteenth century was to allow cities to overgrow themselves, to allow urban life to develop disproportionately to rural life. Attracted by high wages, by prospects of easy living, by the pleasures which undoubtedly come from the foregathering of the people, the young men and women of the country flocked to the city, only to find in the end that the very elements of life — air, food, water, shelter, clothing — were being obtained with increased difficulty and cost, and that ephemeral pleasures and easy conditions of living were being substituted for the solid satisfactions of home life. The decay of home life is reflected in the steadily decreasing birthrate. (The birthrate to-day for the old New England stock is said to be as low as that of France.) We deplore all this, and wonder what we, as a nation, are coming to; but we fail to attack one of the most vital problems, namely the decentralization of population. Congested city life may be efficient, but in the long run it is not beneficient to the mass of the people. Decentralization does not mean doing away with cities; it means substituting many cities of moderate size for a few cities of very large size. State planning is even more important than city planning.

Because the laborer has not received his fair share of the satisfactions of life he has endeavored to get them in the form of increased wages. It seems to me that in many cases this has gone too far. When a carpenter or a plumber or a bricklayer gets more money for his work than the engineer who directs the work, — and this has happened repeatedly of late, — when the laborer earns more than the small trader or the bank clerk or the school teacher or the clergyman, it shows that money rewards are not being given in accordance with what people are contributing to society. Granted that the big fortunes and the earnings of capital have in the past been excessive, it is probably true to-day that there is a strong tendency for the laborer to get too much money for the work he does. But when he gets it he still finds that he cannot procure with it the satisfactions of life; his extra leisure and his money are both spent unwisely. In other words, our money standard of rewards has failed. It has overstimulated enterprise, it has brought about an unwarranted inequality in the distribution of wealth, and it has not brought contentment either to the laborer or the capitalist.

The Engineer and Beneficient Democracy. — The engineer has a unique opportunity to be a great social force in the new democracy, to bring about harmony between work and the worker, to make work beneficient. The engineer is the planner of cities, the designer of factories, the builder of roads and railways, the distributer of power, the digger of mines, the operator of all sorts of industries. What has he planned and built and operated for? Chiefly for product. He ought not to be criticized for that. It is a major element in the problem, and he has been content to consider that as his particular work. But the engineer has greater opportunities than almost any one else to make working conditions and living conditions better for the worker. The engineer is often the inspector of the work done. Why should he not also be the inspector of the worker, and see that his yoke is made as easy and his burden as light as it can be reasonably made? Specifications are drawn for the product of work; why not better specifications for the worker?

It would not be just to say that these things have been altogether neglected. There has been a considerable improvement all along the line in recent years. Health protective measures are being put into specifications, provision is often made for the housing of workmen during construction; safety devices of all sorts are being rapidly put into factories; welfare work of many kinds is in progress; living conditions are improving; but these things have not been done as a matter of course, but rather by the compulsion of law or the benevolence or the patronage of the owner. The laboring people do not want these things in this way; they want them as a matter of custom and right. In fact, at the present moment the labor unions in America do not appreciate them as a great factor in their problem. They have two principal thoughts, — more pay for less work, and uniformity of pay regardless of ability. The labor unions of this country are far behind those of England in appreciating the importance of the conditions under which men and women work and in planning a constructive program to secure these and other benefits for all the people. The labor unions must have a change of heart if they expect to play the noble part in the beneficient democracy which they can play if they will. There are already signs of this change. The entrance of woman into industry is bringing conditions under which people work into the limelight, for women are by nature more influenced by their surroundings than are men. If labor fails to take the fair attitude, is selfish, and overreaches as capital has overreached in the past, the new democracy will fail. Unless American skilled labor adopts a broad-minded, constructive policy, in which the rights and welfare of all are considered, the pendulum will swing far towards proletariat control and then swing back to autocratic conditions. There should be a serious effort on the part of the engineer to prevent it from swinging too far in either direction.

Engineers perform five principal functions, — they advise, design, inspect, construct and operate. In these functions they come close to capital on one side and close to labor on the other. The advisory or consulting engineer and the designing engineer are almost invariably employed by capital. The constructing engineer, the contractor, and the operating engineer are close to labor, and the laborer's pay often goes through their hands. As an inspector the engineer's attitude is judicial. Sometimes these functions are bound up in one individual, but more often designing, construction and operation are in different hands. In fact, the contractor and the operator may not be regarded as engineers at all. Labor, as such, is represented in the walking delegate, a sort of malign guardian angel, who knows nothing except the color of the sheep in his flock, and who seldom, if ever, knows anything about the work which is going on. In my opinion, labor should be better represented, and I know of no one better fitted to protect labor than the engineer.

One of the great underlying causes of present-day labor troubles is that the laborer does not understand what capital really is, does not distinguish it from so-called special privileges, from the unjustified control of the resources of nature. To the laborer, capital is impersonal. The laborer does not know the people whose savings make his work possible, or even the person who handles these savings. Conversely, labor is likewise impersonal to the man of capital. In large establishments the employer does not individually know the people who work for him. This personal knowledge, each of the other, appears at first thought impossible of attainment in a complex civilization, with its enormous cities, its far-furrowed fields, its immense factories, its scattered mines. Individually it is impossible, but collectively it is not. The mine president cannot know all the laborers, but he can know some and through them the others. Not all of the laborers on a job can eat lunch with the big boss, but if a few of them did, once in a while, the acquaintance would be mutually beneficial. The greatest of all problems for the engineer is to help build a bridge between capital and labor. As a rule, the laborers like the engineer; they see him on the job, working in old clothes, measuring, planning, directing; they see him eat and smoke, and they regard him as a human being like themselves. They know, too, that the engineer stands in with the man who is furnishing the money to pay for the job. But to properly fulfill this intermediary position the engineer must broaden his ideas of efficiency from that of the most work for the least cost so as to include benefit to the constructing laborer as he constructs, and benefit to the worker who is to use the constructed plant.

I imagine that an architect reading this will say, " I too occupy an intermediary position between capital and labor"; and so will the lawyer and the clergyman and the factory superintendent. This is true. It will take many men to build this bridge and to induce the human race to travel it.

Let us now turn from these social problems in which the engineer is to find his place to matters of a more definite engineering character.

Public Service. — The unmistakable drift towards the adoption of the so-called socialistic program, whether it be permanent or not, seems likely to place engineering work more and more in the public service. The engineers of the next generation will be employed more and more by the nation, the state and the municipality, and their functions will increase greatly in the direction of executive work.

At the present time we have some anomalous situations. Public-service commissions, state boards of health, and similar organizations are called upon to advise, to approve plans and to otherwise pass judgment on the designs and proposed work of engineers acting independently or employed by private capital. The salaries paid to engineers employed in the public service are in general lower than the earnings of engineers in private practice. The positions are often filled by young men, — usually able, but nevertheless inexperienced. Not infrequently it falls to the lot of these men to pass judgment on plans prepared by other engineers who are far more competent and broad-minded than they themselves, and decisions humiliating to the private engineer and unfortunate to the state are liable to result. The obvious remedy for this condition is to so adjust the rewards of public service that the ablest and most experienced engineers will be attracted to it. These rewards must be expressed in reasonable salaries, but also, and what is perhaps more important, in respect and security of office.

During the last few years the so-called "city manager" plan of municipal administration has rapidly come to the front. This is distinctly a recognition of the engineer. A very large percentage of the city managers thus far chosen comprises men chosen from the ranks of our profession.

After the war many of the engineers who have entered the army and navy will doubtless remain in the service.

Many engineers of great ability have, from motives of patriotism, accepted emergency government positions for compensations far below anything they would consider in ordinary times. If in the coming peace times they can be made to feel that they will be doing their country a great service and one for which their fellow-citizens will give them honor, they will gladly continue in the public service. Certainly there are elements besides monetary considerations which control the acceptance of government positions by engineers.

One result of the entrance of the engineer into public executive life, if such reforms as the initiative and referendum prevail, will be a demand that he display a quality not usually conspicuous among engineers, — the ability to describe a complicated project in such a simple and clear statement that the man on the street can understand it. To describe the merits and demerits of a proposed plan before a board of directors with the drawings before them is one thing; to put the same plan before the voters of a city, in the daily press or in public meetings, is quite another matter. Such a city manager as Mr. Waite, in Dayton, owes his success in great measure, I take it, to his ability to make the people get his ideas. The success of democratic government lies in the intelligent interest which the citizens take in what the officials are doing. More and more, therefore, will it be the business of the engineer to educate the public.

Coördination of Public Service. — The presence of men belonging to one profession in different branches of the public service ought to bring about a closer coördination of these branches. Governmental departments are of necessity specialized, and of necessity there must be direct lines of authority; but unless there are cross lines, short cuts from one department to another, there is tremendous loss of efficiency and great waste. We have done well doubtless to emphasize the organization chart, but unless we organize the cross lines we shall not have a perfect organism. In all this we can learn much from the organization of the human body. The nervous system and the circulatory system are radially planned, but not every function is controlled by the brain. The human body is full of short cuts, and different parts perform many automatic acts. The body politic should also provide for reflex actions.

Such an organization as that of the New York Society of Municipal Engineers, which brings together engineers from all the various departments where engineers are employed, is an example of coördination in a general way. But there is no intrinsic reason why more specific coördination cannot be made as a part of the regular machinery of government.

Conservation. — Professor Swain has said that the conservation of our resources is a social problem. This being granted, is it not the engineer who must guide the people in their use of these resources? He knows the properties, advantages and cost of different resources, and if he will he can advise their use or disuse, looking not only to the benefit of the job at hand but to the possible exhaustion of the supply. He can often find a way to use natural forces instead of power created by the consumption of resources. A gravity water supply instead of a pumping supply may be a wise choice because in the one case coal is used while in the other the force of gravity is used. It is not without significance that the English engineer Tredgold defined engineering as the "employment of the great *forces* of nature for the use and convenience of man." Tredgold did not say the employment of the *resources* of nature. Water power has this advantage over steam power that the rain falls year by year and always will, while coal when it is burned is gone, and more coal can be obtained only with increasing difficulty. Yet, it must not be forgotten that long-distance power transmission by electricity requires the use of copper and other natural resources; and such uses of incidental materials are not to be neglected. In many ways, however, natural forces may take the place of natural consumption of resources. I need not multiply illustrations.

If the state becomes the conserver of the resources of the world, the engineer in government employ will be an important factor in guiding the conservation movement. The war has taught us, as nothing else ever did, the importance of our basic productions, *Foreign Engineering.* — The war is getting the people of the world acquainted with each other. It is getting people to think about the resources of the globe in terms of world-wide necessities. It is elevating business, commerce and transportation to a higher plane than they have ever occupied before. It has emphasized the benefits of organization. The Christian missionaries were the first to take the world view. They were ahead of the business man in all of the far-distant and inaccessible places, and by their self-sacrificing labors they paved the way for a universal civilization. But the business man followed after the missionaries, and the threads of commerce are gradually binding the countries together. Hence the engineer is more and more to find a field for his service abroad.

When one considers Russia and Siberia, — with their resources of field, forest and mine, — China, Japan, the Philippines and India, and when one considers also Africa, South America, Mexico, Cuba and the many tropical islands, it is evident that the resources of the world are very far from being exhausted. More and more must the engineer think in terms of the world.

But in doing so the idea of exploitation must forever be renounced. Of course there must be profits commensurate with the effort; there must be business stimulus; but in the new democracy these rewards must be widely distributed, and the conservation of resources of other countries must be practiced as well as the conservation of our own. To over-develop foreign commerce in natural productions would inevitably lead to further wars. Beneficiency must be practiced abroad as well as at home. The work of engineers in foreign lands will greatly help solve our own problems. Let us take, for example, the control of Chinese floods, the greatest hydraulic problem in the world. If American engineers can help China solve this problem, the problem of the Mississippi will afterwards be as child's play. If American sanitary engineers can teach China how to solve her sewage disposal problem and to utilize the fertilizing elements of human beings in a decent manner it may revolutionize sewage disposal in America.

Foreign service is especially attractive to young men.

The scattering of young men through the English colonies has been of great benefit to Great Britain. It would be well for us to encourage such service in order to interest our educated and influential young men in governmental work and thus raise the standard of the personnel engaged in such work.

Domestic Engineering. — It is not necessary to go abroad to find new fields and new problems. The present war has done much to expand the field. One of the most interesting is the entrance of the engineer into the field of domestic engineering, or, in other words, housing. The health reports of fifty and seventy-five years ago were full of the needs of better housing, and, although a great deal has been accomplished in that time, we are still talking about new building laws and housing laws, and complaining of non-enforcement of regulations. The laws are indeed chaotic and archaic, flawful and awful.

Until recently the engineer has not taken a leading part in providing shelter for the people. House building has been largely an individual matter. But the war has changed all this. Now we see the uncommon sight of engineers constructing houses by hundreds and thousands, building military towns and camps, and organizing companies for wholesale house building. The demand for low-priced houses has become pressing, and the need of temporary houses of laborers at many war plants has been enormous. Engineers and architects are working out details of design and standardizing methods of construction. In standardizing building construction we can learn much from the Chinese. In China and in Korea a beam is a beam, and a board is a board. Houses are built of beams and boards of standard size. Even ornamental features, such as brackets, etc., are standardized. Beams taken from an old house may be again used in a new house. Scaffolding is used over and over. All this has been from necessity, nevertheless it makes mightily for conservation, and does not produce a dreary monotony of buildings, as one might think. With the eyes of the engineers once opened to the possibilities which exist, we may expect to see the whole problem of housing approached from a new point of view and given a strong push towards solution.

City planning is another phase of this problem, and is, of course, much broader than housing. The restriction of buildings in height, bulk and use as in the recent law of New York City is an important development.

Engineering Education. — While I have been using the word "engineer" in the singular number, it is obvious that to carry out the functions outlined the engineering profession must be a great composite of specialists and must contain also many men of broad attainments, education and experience. But all of the varying types of engineers must be held together by a common bond, and that bond is *science.* The engineer applies science, drawing upon natural resources and the forces of nature in a large way for the use and convenience and happiness of man. The love of physical science, respect for mathematical law, and a constructive imagination are the foundation qualities of an engineer, but along with them must go an appreciation of human needs and desires.

To provide this body of specialists in applied science it will be necessary to maintain many engineering schools and to have these differ from each other. There must be manual-training schools, technical schools, and university schools of applied science; schools with courses of two years, four years, five and more years; schools with the usual academic terms, schools which run the year through, schools in which work and instruction are alternated, and schools in the evening. To have all technical schools standardized would be most unfortunate. To have a large number of moderate-sized schools might be better than a few very large schools. Overgrown schools have some of the faults of overgrown cities. There should be more competition in engineering education, but at the same time more coöperation in the use of large and expensive laboratories and machinery and more cross connections between schools.

The war has completely and forever broken down the barrier between pure science and applied science. The teacher of pure science is no longer to live in isolation, to be placed on a pedestal or scornfully regarded as a theorist, and the man whose instincts are for organization and for the utilization of what is known, must not claim too much for his achievements. So also has the barrier broken down between the arts man and the science man, and in my opinion the return to the study of the classics, of language, of literature, of history and of government by men who are planning to be engineers will take place to an increasing extent. The wider work in engineering will need a broader foundation.

Professor Mann, in his studies of engineering teaching in America, has emphasized the needs of character building and personality as primal requisites, and the importance of studying science, engineering practice and the cost of works, and holds that the last two are receiving too little attention in the schools to-day. The reason why this has not been done is, of course, obvious; namely, that in the ordinary four years' course there is not time to study all of the necessary fundamental subjects and at the same time go very far into such matters as practice and cost. To do this properly requires more than four years of study. There ought certainly to be ample opportunities given young men for such extended studies in our great universities. Students intending to be lawyers, ministers or doctors expect to study not four years only, but six or seven. Why should the young man who wishes to become great in the profession of engineering expect to give less time to his preparation for a life's work? In the new democracy the country will need more men of this type.

The Engineering Society as a Graduate School. — On the other hand, many young men cannot afford to study more than four years, some cannot give even that time; and the engineering graduate does not immediately begin to practice or preach, as the doctor or the minister does, but, whatever his training, begins at the bottom and works up. This apprenticeship is necessary, and no amount of schooling can replace it. If the time in school is limited, it is all the more necessary, in my opinion, that it be spent in learning fundamental principles, and that specialization be not carried too far, — not as far as it often is to-day. Where, then, is the young man, the ordinary technical school graduate, to learn about practice and costs and all that? It seems to me that here is an opportunity for the engineering society which has thus far been neglected. Conditions ought to be such that the graduate in engineering entered some professional engineering society as a matter of course. Here he ought to find opportunities for learning about engineering practice and costs, in the best of all ways, — that is, by coming in contact with engineering works themselves and the men who build them. It would not be a difficult matter for engineering societies to offer short courses of lectures given by the older members for the benefit of the younger. And I venture to say that members no longer juniors would be glad to attend such short courses in order to refresh themselves. Too much have our society meetings become mere formal lectures illustrated with lantern slides. These are all very well, but they are not enough. We need the more frequent meeting of small groups. I offer this as a recommendation, — that the Boston Society of Civil Engineers arrange for a few series of short lectures in engineering practice during the coming year, for the benefit of members of the Society.

Individualistic Democracy. — My final thought recurs to the new democracy. I believe that when the good features of the socialist program have been sifted from the bad, — the good ideas adopted and the bad discarded, — there will follow a new organization of society in which individuality will be the prominent note. Although a democracy, it will be a highly specialized and well disciplined and organized democracy, where the natural inequalities of men and women will be recognized and rewarded, but where all will have an equal chance to obtain the great satisfactions of life. But we shall never arrive at this condition unless our students throughout their entire school age are taught to develop their own personalities, unless we adopt some form of democratic military discipline, unless efforts are made to find the right job for the right man, and unless more efforts are made to bring different classes of workers and employers to sympathize with each others' contribution to the common good. But, above all and before everything else, we must win the war.

Vol. V APRIL, 1918 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

ECONOMY IN THE USE OF FUEL IN POWER STATIONS.

By Charles H. Parker,* Member of Boston Society of Civil Engineers.

(Presented before the Sanitary Section, March 6, 1918.)

The Fuel Administrator has lately said that New England needs about 32 000 000 tons of bituminous coal next year. By far the larger part of this is used for power purposes. The cost of this bituminous coal is very large, say $320 000 000, so any general saving of even a few per cent. will run into large figures. Beyond this is the question of transportation facilities and the question of adequate supply of our needs at any price. A saving of only one per cent. due to more economical burning of this coal would mean the release of one 10 000-ton collier for a year, or that the railroads could release 6 400 50-ton coal cars one trip a year for other work. There are many plants where a substantial saving can be made, and very few plants indeed where no saving at all can be made.

The bituminous coals used in New England for power purposes come almost exclusively from Pennsylvania, Maryland or West Virginia, and are among the best coals mined in the United States. The following figures (Table 1), taken from a report of the Boston Chamber of Commerce a few years ago, show the average analysis to be expected in peace times. During the rush of war times, with less careful mining and selection, the ash contents may run considerably higher, and consequently the B.t.u. run lower than given.

---

* Supt. Generating Dept., Edison Electric Illuminating Co., Boston, Mass.

TABLE 1.

District.	Moisture.	Volatile.	Fixed Carbon.	Ash.	B.t.u. Dry Basis.
Broad Top, Pa.	0.71	**15.84**	**72.05**	10.50	14 015
Clearfield, Pa.	2.39	20.47	67.41	9.73	14 086
Cambria, Pa.	2.53	19.50	69.50	8.47	14 324
Somerset Co., Pa.	2.55	17.53	70.52	9.40	14 238
Jefferson Co., Pa.	1.54	30.35	58.55	9.56	13 875
Indiana Co., Pa.	1.32	22.78	65.30	**10.60**	14 048
Westmoreland,* Pa.	3.25	31.08	55.20	10.45	13 849
Pittsburgh, Pa.	2.75	33.91	56.28	7.06	14 259
Georges Creek, Big Vein, Md.	3.02	18.58	69.93	8.47	14 350
Upper Potomac & G. C. Small Vein, Md. & W. Va.	2.75	20.16	67.02	10.07	14 051
Fairmont, W. Va.	2.48	**36.35**	**53.60**	7.57	14 166
New River, W. Va.	2.98	20.47	70.21	**6.34**	14 696
Kanawha, W. Va.	3.49	32.39	57.40	6.72	14 309
Pocahontas, W. Va.	2.86	17.59	72.40	7.15	14 661

With volatile contents running from under 16 per cent. up to over 36 per cent., fixed carbon from 54 per cent. to 73 per cent., and ash from 6.34 per cent. to 10.60 per cent., it becomes very evident that these coals will not all burn alike and that conditions suitable for one coal may not be suitable for another.

Combustion of coal takes place in steps: (1) It absorbs heat to dry it and raise it to the ignition temperature. (2) The hydrocarbons or volatile portion of the coal has to be vaporized and supplied with the necessary oxygen for combustion. (3) The solid or fixed carbon of the coal has to be supplied with the necessary oxygen for combustion.

While the second and third steps are taking place simultaneously, the combustion of the volatile portion is completed long before combustion of the fixed carbon. Where coal is fed in quantity, as in all hand firing, efficient combustion demands that a large volume of air be supplied immediately after coaling, and after the volatile has been burned a lesser amount of air for the combustion of the fixed carbon.

---

* Eastern part.

Another point to be remembered is that during combustion the particles of burning gas or carbon must not be allowed to cool below the ignition temperature, or combustion will cease, with consequent formation of soot and smoke and the loss of heat.

Approximately 7½ lbs. (100 cu. ft. at 70 degrees fahr.) of air per 10 000 B.t.u. are theoretically required for perfect combustion. Due to the impossibility of properly mixing the combustible with the air so as to bring each atom of air to an atom of combustible, excess air must be given for complete combustion.

The aim in all boiler work should be to get complete combustion with the smallest excess of air possible. The best way to find what excess air has been used is to measure the percentage of CO_2 in the flue gas. Best boiler practice rarely exceeds 15 per cent. CO_2, and 12 per cent. to 14 per cent. is good. Anything less than 12 per cent., however, shows loss of heat in chimney gases due to too great an excess of air. Many places have been found where the CO_2 averaged only 5 per cent., showing an excess of air of some 214 per cent.

With a flue gas temperature of 550 per cent., the heat carried away by the dry chimney gases per pound of carbon burned as given by Babcock & Wilcox Co. in "Steam" (p. 158) follows:

15 per cent. CO_2 = 27 per cent. excess air = 1 800 B.t.u.
12 per cent. CO_2 = 54 per cent. excess air = 2 200 B.t.u.
5 per cent. CO_2 = 214 per cent. excess air = 5 250 B.t.u.

Carbon has value of 14 540 B.t.u. when burned to CO_2, so the above losses in heat become —

For 15 per cent. CO_2 .... 12.3 per cent.
12 per cent. CO_2 .... 15.0 per cent.
5 per cent. CO_2 .... 36.0 per cent.

The loss due to incomplete combustion or the formation of CO instead of CO_2 is not serious in most plants unless the combustion chamber is much too small. This is rather difficult to change in an existing plant, but if analysis of the flue gases shows any considerable amount, say .25 per cent., steps should be taken to remedy it. In all new work allow plenty of combustion chamber space, so the gases can be all consumed before they impinge on the heating surfaces. In striving for the higher percentages of CO_2 in flue gases, care must be exercised to see that CO is not formed, for a pound of carbon burned to CO only gives 4 380 B.t.u., while if burned to CO_2 it gives 14 540 B.t.u. Proper admission of air and liberal combustion chambers keep this loss a minimum.

The loss due to combustible in the ash depends on the type of grate or stoker and the carefulness of the fireman in firing and cleaning the fires. This loss may amount to ten per cent. of the fuel. The openings in the grate or stoker should be proportional to the kind of coal to be used, a non-coking coal requiring smaller openings than a coking coal. It is often possible to save a lot of these siftings, especially with stokers, by installing proper hoppers or pans to catch them and keep them out of the ashes. A periodical examination of the ashes carted away is well worth while.

The loss due to water in the coal is twofold — first, if bought with the coal it is very expensive as each per cent. of water means a per cent. of coal paid for and not received; second, it has to be evaporated and superheated to flue temperature. Both together mean about 1.1 per cent. loss for each one per cent. water in the coal.

It is sometimes helpful to wet the coal just before firing on ordinary hand-fired grates, to prevent the rapid release of the volatile hydrocarbons and give a chance for them to be consumed also; on some overfeed stokers wetting may prevent excessive sifting. In each of these cases the loss due to evaporation and superheating to flue temperature is present, but the other gains more than offset it. The water only acts in a mechanical way and adds no heat.

The loss due to visible smoke is usually very small, rarely reaching one per cent. of the coal fired, but dense smoke quite often means bad conditions elsewhere. If the coal is fed in too large amounts, considerable hydrocarbon may be discharged without being burned. It may also indicate too small a combustion chamber. A smoky chimney, however, may be more economical than a clear chimney if the latter is obtained by excessive air dilution. Our smoke-prevention laws make a smoky chimney a nuisance and too expensive to maintain.

Standby losses may be considerable in plants having a fluctuating load, and consist of coal required to start up cold boilers, coal used to bank fires during shut-down periods, heat lost in shutting down boilers, and heat lost in water blown off to get rid of mud and scale from mud drum. The magnitude of these losses are dependent on the character of the load to be carried. Where boilers are not needed for more than twenty-four hours it is usually cheaper to let them go out and build new fires rather than bank them. See that the damper between the boiler and the flue is in good condition, and open only enough during banked periods to carry away the gases, as a badly fitted damper or one left open too wide allows surprisingly large quantities of air to flow through the boiler and cool it.

Flat grates with hand firing work satisfactorily up to 150 horse-power on return tubular boilers and 300 h.p. on water tube boilers, but above that size smokeless combustion is difficult without special arrangements such as Dutch ovens, the Chicago settings, or steam jets.

The Dutch oven containing the grate is placed in front of the ordinary setting. This gives a mass of hot brickwork to heat the liberated volatile matter to ignition temperature, and increases the combustion chamber space, thus giving the gases time to finish combustion before striking the relatively cold boiler surfaces. This may be used on either return tubular or water tube boilers.

The Chicago settings consist of combinations of firebrick arches, baffles and piers built in the combustion chamber to mix the air and volatile matter of the coal and help maintain them at ignition temperature. This is used on return tubular boilers.

Steam jets pointed downward, for forcing extra air over the fire at the front wall, through the side walls, or even through the bridge wall, and mixing it with the volatile matter from the coal, often show good results, both in better efficiency and a lessened amount of smoke. Unfortunately, when these depend on the fireman for operation they do not show the same results commercially as on test. They should be used only while the volatile matter is being driven off, and should be shut off afterwards until the next charge of coal is fired. The ordinary fireman either won't use them at all or will leave them on all the time unless he is closely watched. In the first case, cost of installation has been wasted, and in the second case a lot of steam and the efficiency not bettered, — in fact, it may have been reduced. Steam air injectors can be made automatic and therefore independent of the fireman, but they need careful adjustment to obtain the best economy.

Down-draft furnaces are made with two grates, one above the other. The upper one is made of parallel water tubes connected through headers or drums to the water space of the boiler in a proper manner to insure positive circulation of water. The bottom grate is an ordinary flat grate. Coal is fired on the top grate only. The upper front doors are always left open, and the air passes down through the green coal, mixing with the volatile matter distilled off, and then passes over the incandescent fire below. The lower grate is fed by the half-consumed coal sliced down from the upper grate. Lump coal gives better results than slack, as the latter is apt to fall through too freely. This equipment gives very good efficiency and smokeless combustion where it is carefully handled, not forced, and has the boiler tubes properly covered with fire tile.

Shaking grates assist the fireman in cleaning the fires, often decrease slicing, and assist in maintaining the fire in a loose or broken up condition so the air can get through better. This helps economy, but their general use has been to assist the fireman in getting more capacity.

Semi-bituminous coals, such as New River, Pocahontas, Clearfield, etc., work well with a fire twelve to fourteen inches thick, and should be fired every ten or fifteen minutes. The more volatile coals used in New England are harder to burn efficiently, and the fires should be thinner. With our most volatile coals the fire should not be more than seven or eight inches thick. The thinner the fire, the more often should coal be put on.

The two methods of hand-firing coal used are the coking and spreading. In the coking method considerable coal is fired at the front of the grate and allowed to coke. After the gases have been partly driven off it is pushed back on to the rear part of the fire. This keeps a bed of incandescent fire at the back, over which the volatile matter and air have to pass, and the high temperature assists them in combining. This method is good where the gases have to travel back, as in a return tubular boiler. In the spreading method but little fuel should be fired at one time, and it should be placed evenly over the fire all the way back. Where there are two doors to a furnace, fire them alternately, as the bright fire on the other half of the grate materially assists in burning the volatile matter. This method is good where the path of gases is straight up from the fire. Hand firing produces its best results when it imitates the mechanical stoker, that is, when the coal is fed in very small quantities at short intervals, but has this disadvantage that large volumes of cold air are admitted with each charge of coal.

In large plants, having mechanical means for delivering the coal to the stokers and easy ash removal facilities, mechanical stokers will save considerable labor. In small plants, however, where the coal would have to be shoveled into the stokers and the ashes taken out in wheelbarrows, or barrels; no labor will be saved, and the only justification for installing mechanical stokers is fuel saving and smoke prevention.

Interest on the investment, depreciation, repairs and power for operation are all larger with mechanical stokers than with hand-firing; but mechanical stokers make possible the use of poorer fuels with as high or higher efficiency than is obtainable in hand-firing with better grades of fuel.

Mechanical stokers divide themselves into three general classes: (1) Chain grates, (2) overfeed, (3) underfeed.

Chain grate stokers, such as the "Babcock & Wilcox," Green, Illinois, etc., consist of an endless chain, or belt, around sprockets at the front and rear of the furnace. The belt is made up of short links, sections or bars. The coal is fed by gravity from a hopper on to the front end of the grate, and is carried back to the bridge wall by the grate. During the first part of this travel it is under an ignition arch which drives off the volatile matter and ignites it and the solid carbon. Dampers or baffles should be arranged under the different parts of the grate to control the admission of air. A water box or dampers should be used at the rear end, to prevent excessive leakage of air. The coal is supposed to be all consumed and nothing left but ash when it arrives at the rear end — refuse falls over the rear end, so no cleaning is required, ordinarily.

The chain grate will handle coals high in volatile and ash with very good economy, will be smokeless, and the cost of upkeep will be small. It is not fitted, however, for coals low in volatile matter and ash, and where used with these coals the repairs are excessive and the efficiency poor.

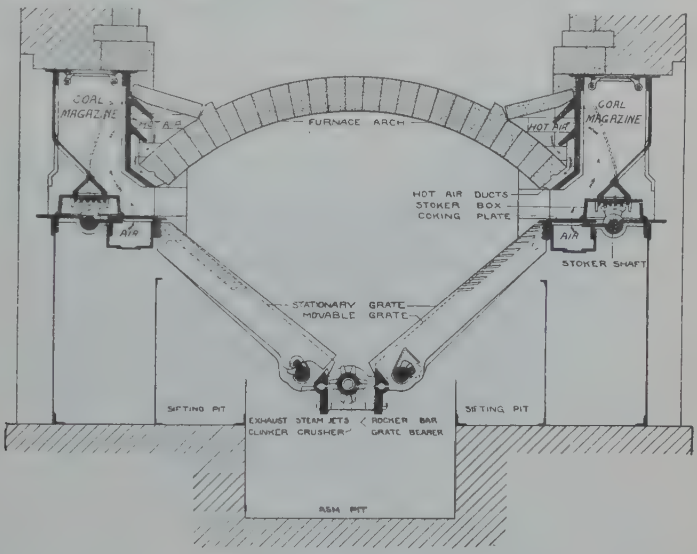
Overfeed stokers divide themselves naturally into the front feed and the side feed. Front feeds are represented by the Roney, Wilkinson and Acme. They have a hopper at the front end, the grate slopes downwards and backwards at about forty-five degrees, the bars or ledges tip and drop the coal from one bar to the next, until it finally reaches a small, flat dumping section at the rear, where combustion is finished. When considerable ashes have collected, the fireman cleans by dumping the grate. Small coking arches at the front ignite the fuel as it starts its travel, and the bright fire below materially assists complete combustion.

The side feed stokers are represented by the Murphy, Detroit and Model, and illustrated by the Murphy (Fig. 1). Here there is a hopper at each side, the full depth of the stoker, pusher plates feed coal on to bars which slope down to the center. Alternate bars are rocked at the bottom end and pivoted near the top. This rocking carries the coal to the bottom of the V, where a clinker grinder drops the ash and clinker through to the ash pit. These stokers have a full fire-brick arch over the whole of the stoker. Hot air is delivered from under the coking plates and the haunches of the main arch to the freshly ignited coal.

All the overfeed stokers are useful for burning semi-bituminous coal when not unduly forced, that is, will handle loads from 100 per cent. to 150 per cent., of rating nicely, and can be forced to around 200 per cent., but the higher rates cause rapid deterioration. The side feed, due to the full ignition arch, are nearer smokeless than the front feed although all of them are satisfactory from this point when carefully handled at light loads.

The underfeed stokers are represented by the Jones, American, Taylor, Riley and Westinghouse, illustrated by the Taylor (Fig. 2) and Riley (Fig. 3).

They all use forced draft. The Jones and American are horizontal, and the others are inclined. The American uses a screw, and the others all use rams to feed the coal in under the fire. With the Jones and American, the coal wells up over the sides and end of trough and the air is forced through tuyère blocks around the trough. Ashes have to be hand cleaned from the dead plates around the troughs. These are usually used on small-sized boilers only.



TRANSVERSE SECTION.

FIG. 1. MURPHY SIDE FEED STOKER.

The Taylor, Riley and Westinghouse are inclined; the main rams feed fuel at the top of the troughs. Taylor uses auxiliary rams, Riley uses reciprocating tuyère sections, and Westinghouse main ram feeds at inclination of grate, to assist the movement of fuel to the bottom, where various kinds of dumping grates, pusher plates and grinders are being tried for getting rid of the ashes. All of them are built up of troughs with sections of tuyères between. There is always one more section of tuyère blocks than there are troughs. These stokers, due to the forced draft, can operate with heavy, thick fires, burn coking coal well, are smokeless, and can be forced to very high overloads. Good quality firebrick must be used in the settings of the boiler and grate, as they produce very high temperatures. They are expensive to install, and the fans have to be maintained, but the chimneys do not have to be very tall and cost of maintenance is not excessive. They make very little smoke when carefully operated. All underfeed stokers can burn the cheaper grades of coal economically, and one man can fire 3 000 or 4 000 h.p. of the inclined type — but not so many of the horizontal type, due to hand cleaning.

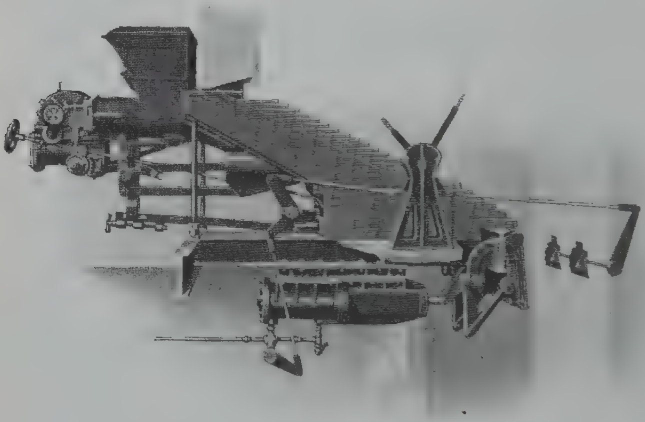


FIG. 2. · TAYLOR UNDER FEED STOKER.

At the present time, unless an addition to plant is required by reason of increased load, the question of fuel saving resolves itself into the best use of the existing plant rather than replacing with new, as the costs are very high and deliveries cannot be made for a year or more in many cases.

Spend a few minutes every day if possible in the fireroom,

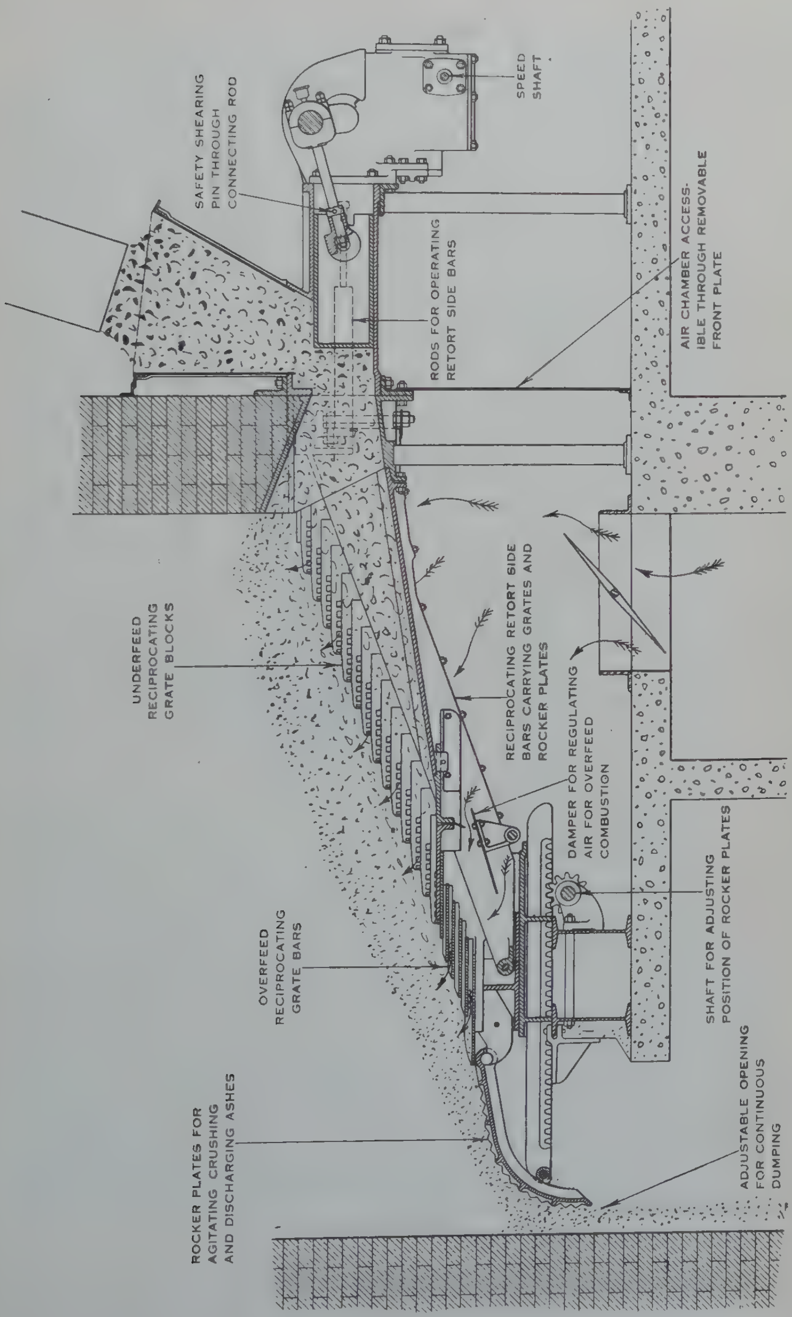

SAFETY SHEARING PIN THROUGH CONNECTING ROD
SPEED SHAFT
RODS FOR OPERATING RETORT SIDE BARS
AIR CHAMBER ACCESSIBLE THROUGH REMOVABLE FRONT PLATE
UNDERFEED RECIPROCATING GRATE BLOCKS
RECIPROCATING RETORT SIDE BARS CARRYING GRATES AND ROCKER PLATES
DAMPER FOR REGULATING AIR FOR OVERFEED COMBUSTION
SHAFT FOR ADJUSTING POSITION OF ROCKER PLATES
OVERFEED RECIPROCATING GRATE BARS
ROCKER PLATES FOR AGITATING CRUSHING AND DISCHARGING ASHES
ADJUSTABLE OPENING FOR CONTINUOUS DUMPING

FIG. 3. RILEY UNDERFEED STOKER.

watching the men at work, and see how they are performing it, also talk to them about it. There are lots of firemen who are good men but who from lack of training and superintendence have fallen into very careless ways. The easiest way is quite often not the most efficient. It is often easier to keep a good steam line with a very heavy fire 16 or 18 ins. thick when an 8 or 10-in. fire would be much more efficient, but the thin fire requires much more frequent attention. The more volatile matter the coal contains the thinner the fire should be. With a thick or a thin fire, it is easier for the man to put in 25 shovels of coal at 25-minute intervals than to put in 14 shovels of coal at 15-minute intervals, because when hoeing and slicing are taken into account the latter method will keep him moving most of the time and the former method allows some rest between, even if he has to shovel more coal actually.

Fire often and light. Don't break up the fire any more than is necessary. Fire one half at a time only. Keep a level fire and allow no holes to burn through. All firemen know this but few really carry it out without watching.

Mechanical stoking also needs careful attention. Do not allow holes or craters to form, do not slice or break up fire with hand tools any more than is necessary. New firemen are very prone to do this, and beyond a limited extent it does more harm than good. Keep the apparatus in good working order so that it will function properly.

In both hand firing and mechanical stoking see that the air supply is adequate and properly regulated to the needs of the fuel and load. By adequate I mean sufficient in amount. I have found a number of firerooms that were so tightly shut up, in winter time especially, that there was a considerable vacuum in them. I once measured a vacuum of several tenths of an inch of water column.

The Babcock & Wilcox Company, in "Steam," give a diagram showing that .5 in. effective draft on the grate will burn thirty-two lbs. coal per sq. ft. of grate and .4 in. effective draft will only burn $27\frac{1}{2}$ lbs. coal per sq. ft. of grate, a loss of 14 per cent. in capacity. Adequate quantities of air should be supplied even if it is necessary to heat it by steam coils, to make the room livable for the fireman. The condensed hot water can go right back into the boiler.

Hand dampers on the boilers should be set to give the requisite draft for the work to be done by the boilers and not opened wide, as is usually the case. If properly set, especially with mechanical stokers, the operation of the main damper will be lessened and the efficiency of the plant increased.

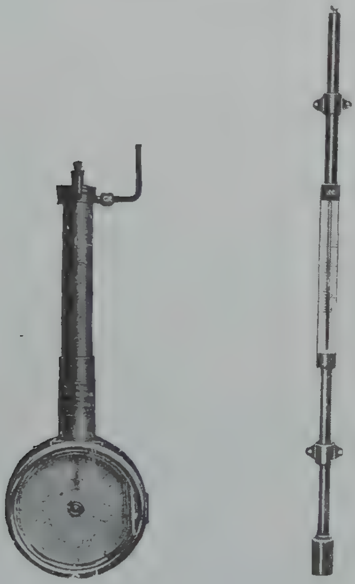


FIG. 4. UEHLING CO_2 RECORDER AND UEHLING BOILER FRONT INDICATOR.

Due to the ease of analyzing the flue gases and finding the percentage of CO_2, and therefrom the economy of combustion, many devices have been brought out to do this with considerbale success either as indicators or as combined indicators and recorders. The simplest is perhaps the Orsat apparatus, but this needs attention and only tells the story for the time at which the sample is taken. A sample can be taken in a bottle, covering a considerable period of time, however, and then a single determination will give the average efficiency during the period.

A better method is to use one of the recorders such as the Uehling (Fig. 4), Sarco, etc., as this gives a continuous record and the fireman can see the effects of his operation. Any CO_2 instrument to record true results needs some little attention itself, and the boiler setting should be tight. The samples are taken in the uptake, and any infiltration of air lowers the apparent CO_2. A good fireman can't make a good CO_2 record if the setting leaks. All CO_2 recorders lag considerably, and need attention.

When several boilers are needed in a plant, a steam flow meter on each is very useful to the man in charge, as he can then easily see which men or boilers are not doing their fair share of the work. There is no economy in having some boilers at very high capacity while others are loafing. The same applies to the men. These help the men also, for if a hole develops in the fire the steam output will drop rapidly, showing that attention is necessary. The General Electric Company and The Bailey Meter Company have good instruments of this class.

Draft gages, showing the draft in various parts of the boiler, are very helpful to a good fireman, or his superintendent, in maintaining proper air proportions. These may be procured of various patterns, from the simple U-tube to types like the Precision Instrument Company's indicators.

The Bailey Meter Company has a boiler meter (Fig. 5) which records on a chart the steam flow on one pen, the gas flow through boiler on another pen (slightly behind the steam pen), the flue temperature, and the draft. The steam flow is obtained by an orifice in steam pipe. Gas flow is obtained by using drop through the boiler instead of an orifice. By the construction of the meter the gas flow pen should track the steam flow pen when the predetermined per cent. CO_2 is taking place. If the gas line gets much above the steam line, too much air is being used or there is a hole in the fire, or the setting leaks somewhere. Conversely, if gas line is much below steam line, too little air is being used, and unconsumed carbon is probably going off as CO instead of CO_2; also smoke is probably being made, laying you liable to a fine, and also depositing dust in the boilers, decreasing efficiency until next cleaning period. This meter, while expensive as meters go, is rugged, accurate and requires very little attention.

Weighing the coal and measuring the water fed to boilers by water meter, weighing device, V notch meter, or Venturi meter, or any other reliable device, is well worth while if studied. Like all other data, however, unless studied and the results acted on to better the efficiency, they are a waste of money.

With a given coal the air, coal and steam quantities should bear a definite relation to get the best efficiency; that is, with different coals the ratios are different, but with a given quality of coal the ratios are fixed, so instruments have been devised to give these. One consists of an electric tachometer operated from the stoker shaft, with auxiliary scales to show coal fed and the force of draft required for best efficiency. When properly graduated for the coal being used, these help the fireman maintain good operating conditions. Draft gages are needed in addition to this instrument, however. These instruments are rugged and require very little attention.

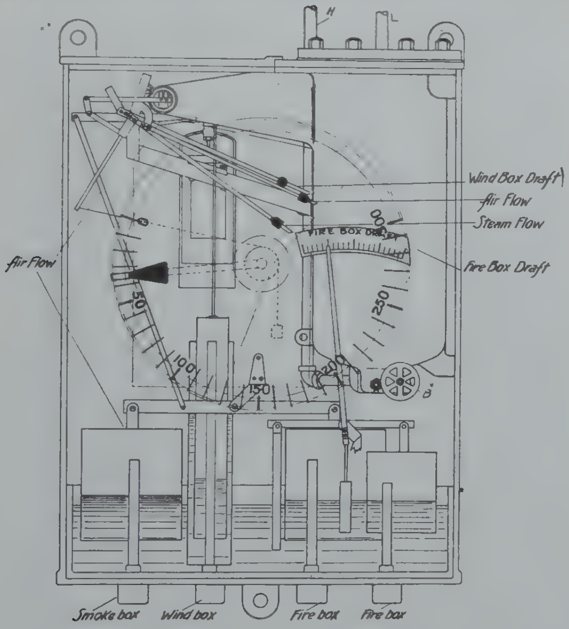


FIG. 5. BAILEY BOILER METER.

Instruments like U-tubes, for measuring draft, are hard to keep clean and are very hard to read in a boiler room, especially after looking at a fire. The newer type instruments all have dust-proof cases, and are much easier to read.

A control panel centrally located, with all of the meters and controls for the operation of one or several boilers mounted on it, is worth every cent it costs, as the stoker operator can tell at a glance which fire needs attention and which are operating satisfactorily. Without this a man must move continually from one fire to another, open doors to inspect the condition, and then not half know due to the blinding glare of the fire; also less opening of doors decreases the amount of cold air admitted, so the economy is better.

There are many places around a plant where a little attention will return considerable savings in fuel. I refer to the leaks. Leaks are of many kinds. There is the leakage of coal as siftings into the ashes, due to too small a shelf or hopper under the stoker; also loss of unconsumed carbon in ash, due to careless cleaning of fires, or by clinker grinders running too fast. There is the loss of heat due to leakage of air through furnace and boiler walls. Keep your settings tight; there are several plastic cements that are good for filling cracks in the brickwork. See that the baffles or flame bridges in the boilers are tight; if they are not, the hot gas short circuits to the flue and escapes without giving up all the heat that it should. Take a look at these yourself, and while looking at them also see if the heating surface of the boiler is clean. Soot is a good non-conductor of heat, and you can't expect good absorption from insulated surfaces. Cleaning heating surfaces is a rather dirty job and disagreeable, but must be done faithfully or the plant efficiency suffers. Permanent soot blowers such as the Vulcan, Diamond (Fig. 6) or Bayer's, make it much easier to keep a boiler clean and use less steam than the ordinary hand lance. They should be picked with judgment, for the particular type of boiler to be used; if the boiler is high and thin, a side-cleaning device like the Bayer is good; if very wide, the side-cleaning type won't clean way across, and the top- and bottom-cleaning type, like the Vulcan and Diamond, is better. If any of the elements must be very close to the fire, the calorized metal of the Diamond will probably give the better life These mechanical cleaners use only about two thirds of the steam the hand lance requires, and do better work generally.

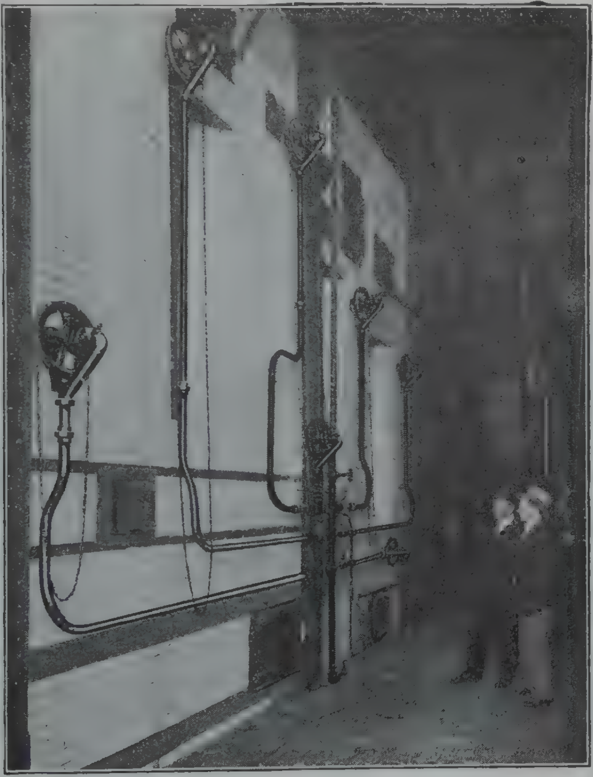


FIG. 6. DIAMOND SOOT BLOWER.

Be sure that the blow-down valve doesn't leak; a small leak here working 1 440 minutes a day will carry away a lot of heat. A good preventive is to use two valves, or a valve and a cock, using one for blowing and the other for holding. Always blow with the same one, so the other will stay tight. Feel of the pipes often — a hot pipe shows leakage.

If steam can be seen anywhere inside or outside of a plant, coal is being wasted. All piping should be kept tight. If steam is being exhausted outdoors make an investigation and see if all is being saved by feed-water heating that is possible. See if exhaust steam cannot take the place of some live steam that is now being used. Exhaust steam contains a very large percentage of the heat originally given it by the boilers, and can be used for many heating and drying processes. There is a prejudice against it in many places that should be overcome.

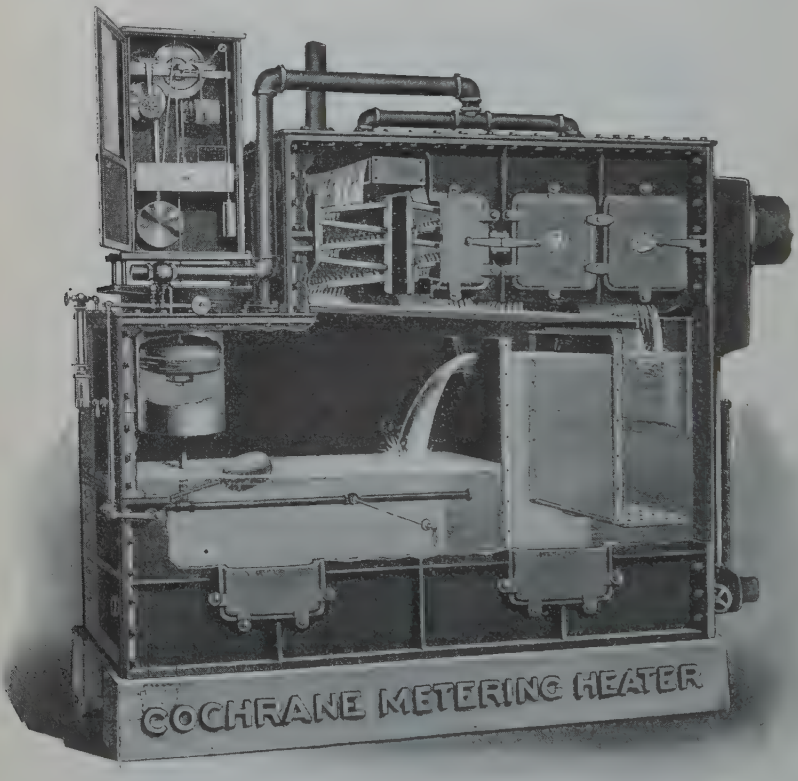


FIG. 7. COCHRANE METERING HEATER.

Steam traps, unless kept in repair, allow considerable loss of heat. Drip pipe ends and trap discharges have a great habit of concealing their ends under water or in out-of-the-way places.

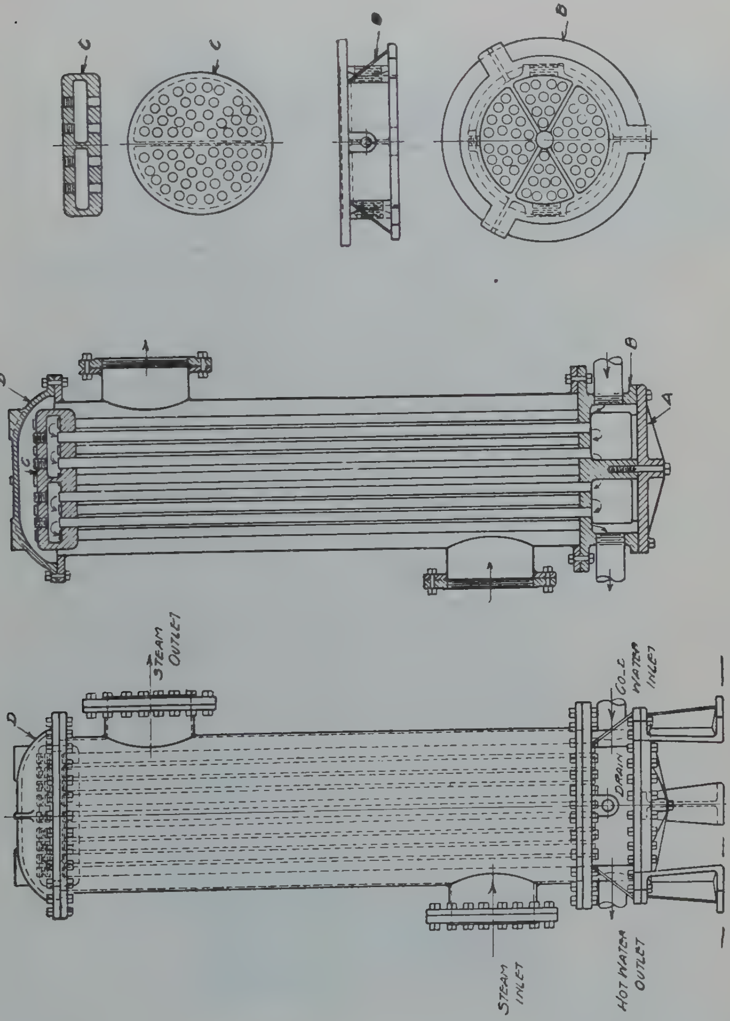


FIG. 8. SINIS TUBULAR HEATER.

This helps the appearance of the plant if they leak, but tends to carelessness in their upkeep. If you can't return these wastes to the feed-water heaters or the system somewhere, at least keep the ends in sight so you know they are tight.

A log sheet giving the starting and stopping of machines and boilers, pressures, temperatures, vacuums, and loads carried, is wasted effort and material unless it is studied and the facts discovered used for bettering the efficiency.

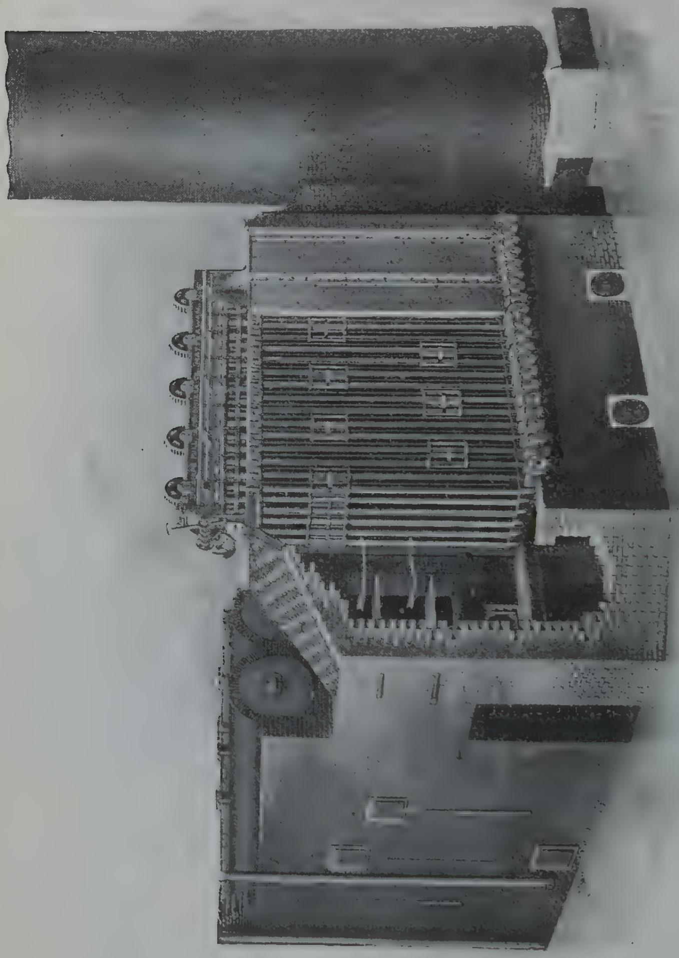


Fig. 9. Green Fuel Economizer.

If steam pressure drops, every one usually knows it, but if feed-water temperature is low all of the time, who is doing anything about it? Is there any heat being wasted that can be saved by heating it? Is the flue gas temperature high, normal or low, and why? If normal, is it due to good operating conditions, or to a large excess of air counteracting dirty heating surfaces? Is the evaporation per pound of coal good? If so, is it due to good operation or only apparent, due to blow-down valve leakages, blowing down, and general wastage of water around the plant, wetting down ashes, etc.?

Is the vacuum proper for the type of prime mover used? Generally speaking, 25 or 26 ins. on good steam engines and the highest possible on steam turbines, 28.5 to 29 ins. or higher.

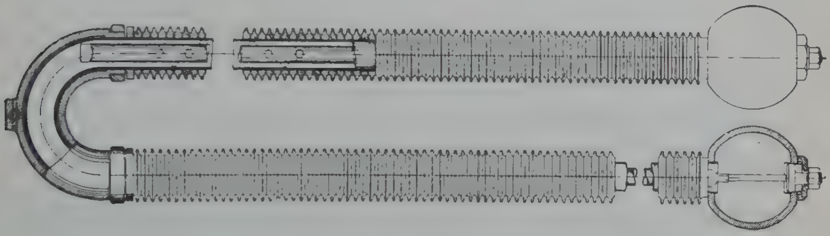


FIG. 10. FOSTER SUPERHEATER — DETAIL OF ONE ELEMENT.

You can save approximately one per cent. of coal for each eleven degrees fahr. that you can raise the feed-water temperature from waste products such as escaping exhaust steam or flue gases, neglecting the cost doing it. So if your feed water is going to the boilers at materially less than 212 degrees, and any steam is being wasted, it would be well to set it at work. If this steam is clean, or contains only a small amount of oil, an open heater (Fig. 7) where the steam and water are brought into intimate contact will give the best results, as all the heat is utilized and the water of condensation is saved.

If the exhaust steam contains much oil or other harmful elements, a closed heater (Fig. 8) is better, as the water and steam are kept separate. Then the water of condensation together with the heat in it are lost. See that your heaters are kept clean, as scale will materially interfere with their heating ability.

Economizers (Fig. 9) are closed heaters for utilizing the waste heat of the flue gases for heating the feed water. They are rather bulky, and often require induced draft fans to assist the stack, as they cause considerable friction to the passage of the gases, and the lowered temperature of the gases reduces the capacity of the chimney. However, where coal is very expensive or there is not exhaust steam enough to heat the feed water, they are of advantage. When high boiler pressures are used, resulting in high flue gas temperatures, economizers show large savings. In existing plants where boilers are poorly designed and have to work at heavy overloads, it might be cheaper to gain capacity by installing an economizer rather than building an extension.

Superheaters (Fig. 10) are either separately fired or are included in the boiler setting. Superheating the steam may produce marked economies in any plant using saturated steam. Each plant, however, should be studied before deciding on the amount to be used and the cost of doing it.

High degrees of superheat are only to be attempted in plants specially designed for it.

Gebhardt, in "Steam Power Plant Engineering," gives for moderate superheating, — that is 100 degrees to 125 degrees fahr., — continuous operation, a fair average reduction of steam per horse-power of:

1. Slow running, full stroke, or throttling engines including pumps, 40 per cent.
2. Simple engines, non-condensing, with medium piston speeds...20 per cent.
3. Compound condensing Corliss engines......................10 per cent.
4. Triple expansion engines..................................6 per cent.

In turbine practice, each ten degrees of superheat usually lowers the water rate one per cent.

Some plants are called upon to carry very heavy overloads for a short time, either periodically or occasionally. Forced draft will often save fuel and money in those cases. If these periods are fairly often, it would be better to install the more expensive fan equipment, as that will only use two per cent. to four per cent. of the steam; but if these occasions are very infrequent it is cheaper to install a steam air injector that may use from five per cent. to ten per cent. of the steam or more. The standby losses of boilers, such as banking, are considerable, and if boilers have to be kept banked for long periods to cover a few emergencies, auxiliary forced draft will be found advantageous.

The steam loop is a simple means of returning the condensation in piping to the boiler, and is adequate for small stations. In plants of several units, however, it does not work so well, and Holly drip return system may be used. By these means all high-pressure drips are saved and the bleeder steam from the nozzle in the upper tank can be put into the feed water heater and the heat saved. The exact saving depends on the men operating the plant and what wastage of steam would be allowed from drips if the automatic arrangement were not used.

DISCUSSION.

Alfred O. Doane.* — It has occurred to me that it might be well to speak of an economy that might be effected by using a mixed fuel which Mr. Parker has not touched upon. Perhaps it is impractical to use it in his station, but in our stations we have had very good success and found that it has relieved the difficulties in this trying period of coal shortage. We mix various sorts of small anthracite in proportions that we have found economical and practical. We do not use water-tube boilers. Our largest boilers are of the Deane type, with vertical tubes, and we have always made it a practice to burn a certain percentage of screenings and small-sized anthracite, — finding it advantageous from two or three standpoints. We can generally realize a small saving in dollars and cents in addition to securing a smokeless operation. During this coal shortage we have made an attempt to burn still larger proportions of anthracite and the limit of our operations seems to be the draft available, and as we use economizers the draft is somewhat cut down, from causes that Mr. Parker has stated. We have put in some blowers very much like automobile fans, and by these, making a slightly increased pressure under the grate, we have been able to burn a considerable proportion of fine anthracite, resulting in some saving of coal. We have found, however, that there are some precautions to take, especially when using a vertical tube boiler which is very sensitive to undue heat on the ends of the tubes. The water may be driven away from the tube sheet, causing the ends of the tube to burn, and holes in the fire may result. But by putting in about one-quarter inch air spaces, the trouble is largely obviated so that we can burn about eighty per cent. of this fine coal with advantage. With natural draft we have found the limit of efficiency to be about fifty per cent. or sixty per cent. The trouble seems to be that while you can burn a large portion, there are losses due to two causes. First, with too large a proportion of fine coal much will sift through the grate and be lost in the ashes. Second, lack of draft causes imperfect combustion, as it is impossible to get oxygen enough through the fire to burn the fuel efficiently. We have found economizers advantageous, as most of our main units, the air pump and feed pumps, are driven directly from reciprocating parts of the machinery so that we have practically no heat from auxiliaries for the feed water. The economizer takes care of that, and also affords a settling chamber for a very considerable amount of dirt and scale-forming material which might otherwise reach the boiler. The matter of measuring feed water may be mentioned. As we use reciprocating engines, etc., we do not consider it safe to put water that has a suspicion of oil into our boilers, especially as the type of oil we use is very sensitive to that sort of thing. So we have to use closed heaters, and in most of our plants the water has to be measured after it has been heated to some extent. We have had much trouble trying to find a satisfactory hot-water meter. It is impossible to use rubber disks and all metal disks wear rapidly and give out. Finally, we got some Venturi meters which have given very excellent satisfaction, but are expensive, — especially the registers, — so that for most small plants they would probably not be feasible. I would like to emphasize particularly one of the points that Mr. Parker brought out, and that is to take care of the settings of any brick set boilers, to be sure there is no leakage of air, which will greatly cut down the economy. This is something that has to be followed up constantly, as cracks which open and close, and often are almost invisible will let in a surprising amount of cold air.

---

* Division Engineer, Mass. Metropolitan Water and Sewerage Board.

FRANK B. SANBORN.* — We ought to thank Mr. Parker for allowing us to visit his plant. I am sure all who visited it and all who have heard Mr. Parker have been impressed with the opportunities for study that exist there and the splendid developments they are making at that plant. I have one or two questions I would like to ask Mr. Parker. One is concerning the means for measuring the feed water. Mr. Doane spoke of the Venturi meter, while the speaker showed a triangular meter. I wondered if the triangular meter would not cost a good deal less and still give pretty nearly as good efficiency.

MR. PARKER. — There are several kinds of weirs being used with great success. One is the V notch and the other is a particular curve. I have forgotten just what it is now, but it is curved down to a point so that equal increments of rise give equal increments of water flow, so that a recording chart can be very easily placed on one of those meters. There is also another type of meter which consists of buckets that will hold a thousand pounds of water, for instance. Water flows into them, and when it fills this bucket it is dumped over and you get a certain volume of water at the temperature of the feed water, and it is recorded right there. You can get an indicating meter which is not very expensive. They have a lot of apparatus to-day for measuring fairly hot water that are not very expensive. The hot-water meter of the old-fashioned type is no use at all after a short time.

MR. DOANE.—I perhaps did not make it clear enough that we are under the necessity of using closed feed-water heaters with the water under pressure, so that we are not able to use any of these notch segments. It is the Venturi register, of course, that is the expensive thing; but unless you have the register it is almost impossible to keep track of the flow with an indicator or anything of that kind. There was one experience we had with Venturi meters which may be of interest. That was that our very long single-action feed pump developed a high vibration and kick in the pipe, which the ordinary air chambers did not seem to take care of, but we devised, after considerable trouble, a very large air chamber in which the water was taken through in a certain way that practically obviated the trouble and made the Venturi register act very much better, as it almost entirely stopped any vibration of the pen arm of the meter. If you have considerable vibration, it is practically impossible to get correct measurements with the Venturi meter.

---

* Professor of Civil Engineering, Tufts College, Mass.

FRANK A. MARSTON.* — An interesting example of the installation of an undergrate draft apparatus to economize in the cost of fuel, was recently brought to the writer's attention at Canton, N. Y. For the following information credit is due Mr. L. R. Smith, superintendent of the Canton Water Works.

The apparatus installed is a steam-turbine driven, propeller fan, automatically controlled by the steam pressure acting on a balanced valve which also controls a damper regulator. It was manufactured by the Coppus Engineering and Equipment Company, of Worcester, Mass. The level arm of the damper regulator is connected to the damper and to the lever attached to the balanced valve controlling the supply of steam delivered to the turbo blower, so that when the regulator closes the damper it also shuts the balanced valve, cutting off the steam supply to the blower and thus reducing or stopping the undergrate draft. As long as the steam stays at the desired pressure, the blower does not operate. When the steam pressure falls below the required amount, the damper and the balanced valve both open, the blower starts the draft, and the steam pressure is brought back to the desired point. The blower is then shut down and the damper closed, as first described.

The cost of the apparatus installed complete was about $225. Information is not available for an exact statement of the fuel economy, but a general idea of the results can be gained from the following notes.

When the blower was installed, two or three years ago, about forty net tons of three-quarter lump bituminous coal were burned per month. After installing the blower, a mixture of 75 per cent. anthracite yard screenings and 25 per cent. three-quarter lump bituminous coal was burned, requiring 10 per cent. more coal in total quantity. The conditions as to pumping were substantially the same.

---

* Designing Engineer, with Metcalf & Eddy, 14 Beacon Street, Boston, Mass.

At the present time (February, 1918), three-quarter lump bituminous coal costs $8.00 per ton and anthracite yard screenings $3.00 per ton (2 000 lbs.). On this basis the saving amounts to about one hundred dollars per month.

The labor of firing the boilers is somewhat easier, even though the quantity to be handled is greater. There are two return tubular boilers of 85 h.p. each, hand stoked. The steam pressure is maintained at from 90 to 100 lbs. per sq. in.

No additional wear on the boilers has been noticed, although it may be that there is greater depreciation because of the increased draft. The apparatus is rather noisy, which for some locations might be objectionable.

MEMOIR OF DECEASED MEMBER.

ALBERT SEWARD GLOVER.*

Born April 6, 1855. Died April 23, 1917.

ALBERT S. GLOVER was born at South Boston on the date noted above. His father was Albert Henry Glover, originally of Ipswich, Mass., and his mother was Mary Ann Wilson, of Salem. His parents moved to Cottage Farm when he was a young boy, and to West Newton in 1864. For many years Mr. Glover's father was master builder for the Boston & Albany Railroad, having charge of the construction of various wooden bridges and buildings, some of them very large.

Albert S. Glover attended the Newton High School, where he was a leader in athletics, particularly in baseball and football. He was graduated in 1873, being a classmate of John A. Gould. In the fall of that year he entered the Massachusetts Institute of Technology with the class of 1877, having as classmates Prof. George F. Swain, Richard A. Hale, Henry H. Carter, Joseph P. Gray, Charles F. Lawton, George W. Kittredge, the late E. H. Gowing, and other well-known engineers.

In 1875, when work on the Sudbury Water Works for the City of Boston was actively begun, Mr. Glover left the Institute and took a position on the engineering force, being associated with Frederic P. Stearns, George S. Rice, Wilbur F. Learned, and others. A little later he was assigned by the engineer, Mr. Alphonse Fteley, to act as his secretary, and as assistant to the paymaster and purchasing agent; and in 1879 he became paymaster and purchasing agent. In July, 1879, he was elected water registrar of the City of Newton — the executive officer of the Water Department — and held that position until January 1, 1890, when he resigned to become secretary of the Hersey Manufacturing Company, having charge of sales of Hersey meters in New England. To this work he devoted the remainder of his life. He was also clerk of the Common Council of Newton from 1882 to 1887.

---

* Memoir prepared by Richard A. Hale and Charles W. Sherman and taken largely from the very complete memoir published in the Journal of the New England Water Works for June, 1917.

Mr. Glover was married, on September 21, 1875, to Mary Wales Robinson, of Newton, who survives him, with their daughter, Mary Wales Glover, a graduate of Smith College.

He was a member of the following societies and clubs, in addition to the Boston Society of Civil Engineers, American Water Works Association, New England Water Works Association, Newton Club, Boston City Club, Engineers Club, Hunnewell Club, Middlesex Club, Economic Club, Bostonian Society, Brae Burn Country Club, Tedesco Country Club. He became a member of the Boston Society of Civil Engineers on June 17, 1885.

Vol. V APRIL, 1918 No. 4

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

INDEX TO ADVERTISERS.

Page
A. B. See Electric Elevators, 111 Devonshire St., Boston....... xiv
Aberthaw Construction Co., 27 School St., Boston............. xiii
Adams, H. S., 108 Ames Building, Boston, Mass................. iii
Aspinwall & Lincoln, 3 Hamilton Pl., Boston................. iii
Associated Architects Printing & Supply Co., 144 Congress St., Boston................. xiii
Bay State Dredging and Contracting Co., 62 Condor St., East Boston................. ix
Beattie, Inc., Roy H., 70 Kilby St., Boston.................... xii
Bishop, J. W., & Co., 683 Atlantic Ave., Boston................. x
Blair, Isaac, & Co., Inc., 433 Harrison Ave., Boston............ x
Bond, Harold L., Co., 383 Atlantic Ave., Boston............... vii
Buss, Edward A., 85 Water St., Boston....................... iii
Coleman Bros., 1 Marginal St., Chelsea....................... xii
Dixon Crucible Co., Jersey City, N. J......................... xii
Eastern Bridge and Structural Co., Worcester................ xiv
Fay, Spofford & Thorndike, 308 Boylston St., Boston.......... iii
Fort Hill Press, 176 High St., Boston........................ xiv
Fuller, George W., 170 Broadway, New York................. iii
Gow, The Charles R., Co., 166 Devonshire St., Boston......... xi
Hall, John G., & Co., 114 State St., Boston.................... xii
Harrington, Ephraim, 20 Pemberton Sq., Boston............... iii
Hersey Mfg. Co., South Boston............................ xvi
Holbrook, Cabot & Rollins Corpn., 6 Beacon St., Boston...... vi
Holzer, U., 25 Bromfield St., Boston.......................... ix
Hughes, Edward F., 8 Oliver St., Boston..................... xii
Jackson, D. C. & Wm. B., 248 Boylston St., Boston............. iii
Jonsberg, F. F., Co., 733 Old South Building, Boston........... x
Ledder & Probst, 56 Franklin St., Boston...................... xii
Ley & Co., Inc., Fred T., Springfield, Mass.................... xv
Main, Charles T., 201 Devonshire St., Boston................. ii
Metcalf & Eddy, 14 Beacon St., Boston....................... iii
Morse, William F., 90 West St., New York.................... iii
New England Bureau of Tests, Inc., 12 Pearl St., Boston....... iv
New England Foundation Co., Inc., 70 Kilby St., Boston....... xii
New England Sand & Gravel Co., West Peabody, Mass......... vii
Old Corner Book Store, 27 Bromfield St., Boston.............. xii
Palmer, John E., 1012 Old South Bldg., Boston................ xii

	Page
Penn Metal Co., 201 Devonshire St., Boston	iv
Pennsylvania Cement Co., 161 Devonshire St., Boston	x
Perrin, Seamans & Co., 57 Oliver St., Boston	xi
Rideout, Chandler & Joyce, 178 High St., Boston	xii
Rockport Granite Co., Rockport, Mass.	v
Simpson Bros. Corpn., 166 Devonshire St., Boston	v
S-M-I Engineering Company, 136 Federal St., Boston	iv
Smith, B. F., & Co., 60 Federal St., Boston	xii
Stone & Webster, 147 Milk St., Boston	viii
Thompson, Sanford E., 136 Federal St., Boston	iii
Thorpe, Lewis D., 201 Devonshire St., Boston	iii
Tucker, Edward A., Co., 683 Atlantic Ave., Boston	v
Waldo Brothers, Boston	ix
Warren Foundry and Machine Co., 111 Broadway, New York	vii
Weston & Sampson, 14 Beacon St., Boston	iii
Whitman & Howard, 220 Devonshire St., Boston	iv
Witherow Steel Co., 185 Devonshire St., Boston, Mass.	xiii
Wood, R. D., & Co., Philadelphia	vii
Worcester, J. R., & Co., 79 Milk St., Boston	iv

PROFESSIONAL CARDS

CHAS. T. MAIN

ENGINEER

201 Devonshire Street, Boston, Mass.

Rooms 817-833

Plans and Specifications for the erection and equipment or reorganization of textile mills and other industrial plants, including steam and water-power plants

H. S. ADAMS

Consulting Engineer

108-9 AMES BUILDING
BOSTON, MASS.

D. C. & WM. B. JACKSON

Consulting Engineers

FOR ELECTRIC AND
ALLIED PROPERTIES

CHICAGO
Harris Trust Bldg.

BOSTON
248 Boylston St.

ASPINWALL & LINCOLN

Civil Engineers

3 HAMILTON PLACE
BOSTON

METCALF & EDDY

Leonard Metcalf
Harrison P. Eddy
Charles W. Sherman
Wm. T. Barnes
Almon L. Fales

14 Beacon Street
Boston, Mass.

Harris Trust Building
Chicago, Ill.

Water Supply and Sewerage

EDWARD A. BUSS

Mill Architect and Consulting Engineer

New Construction, Rearrangements, Electrical Equipment, Economy of Operation

85 Water St., Boston, Mass.

WILLIAM F. MORSE

90 WEST STREET, NEW YORK CITY

Consulting Sanitary Engineer

Surveys, Reports, Estimates, Plans and Specifications for

Garbage and Refuse Disposal Plants

MUNICIPAL — INSTITUTIONAL — INDUSTRIAL

The modern approved methods of Disposal by Incineration or Reduction

---

FAY, SPOFFORD & THORNDIKE

Consulting Engineers

BRIDGES AND OTHER STRUCTURES OF STEEL AND MASONRY. FOUNDATIONS. RIVER AND HARBOR WORKS

FREDERIC H. FAY
CHARLES M. SPOFFORD
STURGIS H. THORNDIKE

308 Boylston Street, Boston, Mass.

SANFORD E. THOMPSON

M. Am. Soc. C. E.
M. Am. Soc. M. E.

Consulting Engineer

Design of Steel and Reinforced Concrete; Review of Plans; Estimates and Appraisals; Tests of Cement and Concrete; Organization of Construction and Industrial Work.

OFFICES AND LABORATORY
136 FEDERAL STREET, BOSTON

GEORGE W. FULLER

M. Am. Soc. C. E.
M. Am. Inst. Cons. E.

Consulting Hydraulic Engineer and Sanitary Expert

JAMES R. McCLINTOCK

Water Supply and Purification, Sewerage and Drainage, Disposal of Sewage and Refuse, Investigation of Epidemics, Public Utilities Valuations, Supervision of Construction and Operation.

170 Broadway, New York, N. Y.

LEWIS D. THORPE

Civil and Sanitary Engineer

Water Works, Sewerage and Sewage Disposal

Supervision of Construction and Operation

201 Devonshire Street
BOSTON, MASS.

EPHRAIM HARRINGTON

M. Am. Soc. C. E.

Consulting and Advisory Engineer

EXAMINATIONS, ESTIMATES AND REPORTS.
Private and Municipal Improvements and Developments.
PRELIMINARY SURVEYS, DESIGNS AND SUPERVISION.

20 Pemberton Sq.
Boston

WESTON & SAMPSON

ROBERT SPURR WESTON
G. A. SAMPSON

Laboratory for the Analysis of Water, Sewage, Filtering Materials, etc., Design, Inspection and Supervision of Water Purification and Sewage Disposal Plants.

14 BEACON STREET, BOSTON, MASS.

WHITMAN & HOWARD

Civil Engineers

(Established in 1869)

220 Devonshire Street Room 504
BOSTON

J. R. Worcester E. E. Pettee G. H. Brazer
MEMBERS OF AM. SOC. C. E.

J. R. WORCESTER & CO.

Consulting and Designing Engineers

Bridges Foundations
Steel and Reinforced Concrete Construction

79 MILK STREET, BOSTON

Cement Testing Laboratory at Waltham, Mass.

S-M-I ENGINEERING COMPANY

REINFORCED CONCRETE AND STEEL ENGINEERS

S-M-I FLAT SLAB CONSTRUCTION. DESIGN OF REINFORCED CONCRETE AND STEEL. SUPERVISION OF CONSTRUCTION.

ESTIMATES

136 FEDERAL ST., BOSTON, MASS.

48 Years of Service

METAL LATH
CONCRETE REINFORCEMENT
CULVERT PIPE

SHEET IRON AND STEEL BUILDING MATERIAL OF EVERY NATURE

USE HAMPTON METAL
"IT WATCHES OTHERS RUST"

Penn Metal Company
201 Devonshire Street
Boston, Mass.

SALES OFFICES
New York, N. Y. Portland, Me. Philadelphia, Pa.

FACTORIES
Boston and Cambridge, Mass.

NEW ENGLAND BUREAU OF TESTS, Inc.

Inspecting Engineers and Chemists

Herbert L. Sherman, President
Joshua L. Miner, First Vice-President
A. B. Bellows, Second Vice-President
Wm. F. Zimmermann, Secretary

Tests and inspection of Iron and Steel, Cement and Concrete Materials, Road Materials, Pipe, Wire and Machinery of all kinds.

Chemical Analyses and Research.

Our own laboratories and inspectors at all important points.

12 Pearl Street
BOSTON

'Phone, Fort Hill 3038

SIMPSON BROS. CORPORATION

TRADE MARK REG.
LAID BY
SIMPSON BROS.
CORPORATION
166 DEVONSHIRE ST.
BOSTON

ENGINEERS AND CONTRACTORS
FOR
REINFORCED CONCRETE
CONSTRUCTION

ROCK ASPHALT FLOORS — GRANOLITHIC FLOORS.
SIDEWALKS, CURBING, STEPS, BUTTRESSES, ETC.
SIMBROCO CONCRETE STONE BUILDING TRIM.
HASSAM CONCRETE STREET PAVEMENT.

ROCKPORT GRANITE
permanently resists all action of Sea Water

It is an undeniable fact that chemical changes take place in the cement of CONCRETE construction exposed for any number of years to sea water, changes that are certainly not for the better.

No changes take place in Rockport Granite. It is permanent, and it is impermeable; and these FACTS are beyond question. The same facts apply to masonry work of every description — Rockport Granite is the ONE material of PERMANENCY.

A combination of Quality and Low Price is offered in Rockport Granite, full details of which will be supplied upon request. Write.

ROCKPORT GRANITE CO. - RocKport, Mass.
C. HARRY ROGERS, Treas. and Gen'l Mgr.
BRANCHES:
New York, 21 Park Row, Represented by F. E. Foster. Chicago, Chamber of Commerce Bldg., Represented by J. D. Duffy. Boston, 31 State St. Winnipeg, Canada, N. J. Dinnen Co.

EDWARD A. TUCKER COMPANY
Concrete Engineers

Designs and Estimates Submitted *Structural Steel*
Concrete Reinforcement *Fabrication and Erection*

ESSEX BUILDING - 683 ATLANTIC AVENUE, BOSTON
Opp. South Station
Direct Mill Connections Warehouse, Cambridge Shop, Camden, N. J.
Telephone, Oxford 4670

Holbrook, Cabot & Rollins Corp'n

Contractors

Heavy Masonry and Concrete Construction, Deep Foundations

6 BEACON STREET BOSTON, MASS.

52 Vanderbilt Avenue
New York, N. Y.

JAMES W. ROLLINS, President
FREDERICK HOLBROOK, Vice-President
WILLIAM S. PATTEN, Vice-President
THOMAS B. BRYSON, Secretary and Treasurer

NEW ENGLAND SAND AND GRAVEL CO.
PEABODY 244 WEST PEABODY, MASS.
SCREENED, SIZED AND WASHED
BANK SAND AND GRAVEL
ONE CAR OR A TRAINLOAD
CONCRETING, GRANOLITHIC AND ROOFING GRAVEL
BUILDING AND CONCRETE SAND
PROMPT AND RELIABLE SERVICE

PROMPT SERVICE GOOD QUALITY FAIR PRICES
HAROLD L. BOND COMPANY
HAROLD L. BOND, Pres. GEORGE S. HEDGE, Treas.
TOOLS AND MACHINERY
For All Forms of Construction Work
Boilers, Engines, Pumps, Dump Cars, Derrick Fittings, Blocks, Rock Drills, Dynamite, Blasting Supplies, Iron and Steel
RAILROAD, MILL AND CONTRACTORS' SUPPLIES
383-391 ATLANTIC AVENUE : : : : : BOSTON
Long Distance Telephone

WARREN FOUNDRY AND MACHINE CO.
111 Broadway, New York City
MANUFACTURERS OF
Cast Iron Gas and Water Pipe
ALSO ALL KINDS OF FLANGE PIPE AND SPECIAL CASTINGS

R. D. Wood & Company,
Philadelphia, Pa.
Engineers Iron Founders Machinists
Pumping Engines, Centrifugal Pumping Machinery, Gas Producer Power Plants (and big installations) Gas Holders, Cast Iron Pipe, Valves and Hydrants, Water and Gas Works Appliances.

STONE & WEBSTER

FINANCE public utility developments.

BUY AND SELL securities.

DESIGN steam power stations, hydro-electric developments, transmission lines, city and interurban railways, gas plants, industrial plants and buildings.

CONSTRUCT either from our own designs or from designs of other engineers or architects.

REPORT on public utility properties, proposed extensions or new projects.

MANAGE railway, light, power and gas companies.

NEW YORK BOSTON CHICAGO

Bay State Dredging & Contracting Co.

Contractors

Heavy Masonry and Concrete Construction, Deep Foundations

62 Condor St., East Boston, Mass.

Telephones
East Boston 1834
East Boston 1835
East Boston 28

JAMES E. CASHMAN, Treas. and Gen. Mgr.
GORHAM H. WHITNEY, President
DAVID J. WHITE, Secretary

WALDO BROTHERS, Incorporated

45 BATTERYMARCH ST.
BOSTON, MASS.

High-Grade Building Materials

U. HOLZER,

BOOK-BINDER

25 Bromfield St., Boston, Mass.

ESTABLISHED 1870.

All kinds of Books bound and repaired.
Maps and Charts mounted.
Portfolios, Scrap Books, Blank Books, etc., made to order.
Lettering in Gold; Paper-Splitting; Inlaying; etc.
Photographs Mounted on Card or Paper without Cockling.

Telephone
and
Elevator

F. F. JONSBERG CO.

Engineering Construction
Switch Cell Construction

733 OLD SOUTH BUILDING
BOSTON

THE EXTREME HIGH QUALITY OF
PENNSYLVANIA PORTLAND CEMENT
MAKES ITS USE ESSENTIAL WHERE
WORK OF THE HIGHEST CLASS IS DESIRED

PENNSYLVANIA CEMENT CO.

NEW YORK OFFICE
30 East 42d St.

BOSTON OFFICE
161 Devonshire St.

NEW YORK
101 Park Avenue

BOSTON
683 Atlantic Avenue

J. W. BISHOP COMPANY
GENERAL CONTRACTORS

PROVIDENCE
617 Butler Exchange

WORCESTER
109 Foster Street

GEO. A. BLAIR L. L. STREET W. O. WELLINGTON

ISAAC BLAIR & CO., Inc., General Contractors
Shoring and Moving Buildings a Specialty
433 Harrison Avenue, BOSTON

THE CHARLES R. GOW COMPANY

Contractors for Engineering Construction

No. 166 DEVONSHIRE STREET

BOSTON, MASS.

PERRIN, SEAMANS & CO.

Machinery, Tools and Supplies

FOR

Construction Work

57 OLIVER STREET, BOSTON

EDWARD F. HUGHES

Artesian and Driven Wells

for

Manufacturing, Public or Private
Water Supply

954 Oliver Building, 8 Oliver Street, Boston, Mass.
TEL. 1633 MAIN

SCIENTIFIC BOOKS

AND PERIODICALS

THE OLD CORNER BOOK STORE

27-29 Bromfield Street
BOSTON, MASS.

Made for C. E. draughtsmen, and in 17 degrees.

DIXON'S ELDORADO

"the master drawing pencil"

DIXON'S ELDORADO HB

Write on your letterhead for samples.

JOSEPH DIXON CRUCIBLE COMPANY
JERSEY CITY, N. J.

JOHN G. HALL & CO.

114 STATE STREET, BOSTON

=PILING=

JOHN E. PALMER

Contracting Engineer

Contractor for Sewers, Water Works, Concrete Bridges, Concrete Foundations, etc.

Room 1012, Old South Building
Boston, Mass.
Telephone, Fort Hill 1731

LEDDER & PROBST, Inc.

56 Franklin Street, Boston, Mass.

Surveying Instruments

REPAIRING

BLUE AND BLACK PRINTS

Drawing Materials

C. D. Kirkpatrick, *Mgr.* S. P. Gates, *Asst. Mgr.*

B. F. SMITH & CO., INC.

Established 1878

ARTESIAN AND DRIVEN WELLS
FOUNDATION BORINGS

Engineers and Contractors for Municipal and Private Water Works

Office: 1st NATIONAL BANK BUILDING,
60 FEDERAL STREET, BOSTON, MASS

RIDEOUT, CHANDLER & JOYCE

Engineers and Piping Contractors

178 HIGH STREET - BOSTON, MASS.

Steam Specialties, Engineers' Supplies
Piping of All Kinds Furnished or Erected

New England Foundation Co., Inc.

Engineering and Construction

Simplex Concrete Piles

70 KILBY STREET :: :: BOSTON, MASS.

ROY H. BEATTIE, Inc.

Harbor Improvements
Divers :: Lighters

70 KILBY ST., BOSTON, MASS.

COLEMAN BROS.

General Contractors

Main Office
1 Marginal St.,
Chelsea

Boston Address
166 Devonshire St.

Associated Architects Printing & Supply Co.

144 CONGRESS STREET, BOSTON

BLUE, BLACK AND VANDYKE PRINTING ON PAPER OR LINEN
BLACK ON WHITE REPRODUCTION PROCESS—ANY COLOR
DRAWING MATERIALS AND SUPPLIES

TELEPHONE, FORT HILL 4013

BENDING
WORKING DRAWINGS

LUMP SUM OR
MILL QUOTATIONS

WITHEROW STEEL COMPANY
REINFORCING BARS FOR CONCRETE

185 DEVONSHIRE STREET
BOSTON, MASS.
TELEPHONE, FORT HILL 4015

WALTER T. PALMER
N. E. MANAGER

The Home of Carter's Inx

The Security of Safety

Every engineer, every manufacturer, enjoys having a capable organization behind his project or his plan.

Our business is specializing in concrete, and our experience has fitted us to undertake all manner of work, with the construction varying from dams to mammoth industrial plants.

We do the work on the cost-plus-profit basis—an exchange in mutual confidence, of value received and satisfaction given.

This is the method which has distinguished our success in reinforced concrete, brick or steel.

ABERTHAW CONSTRUCTION CO.

Contracting Engineers Specializing in Concrete

27 SCHOOL STREET (6-53) BOSTON, MASS.

SAMUEL USHER
ESTABLISHED 1881
The Fort Hill Press
A Modern Plant
Accuracy and Excellence
BOOK-MAGAZINE-CATALOG
LAW & JOB PRINTING
176 TO 184 HIGH STREET,
FORT HILL SQUARE
BOSTON, MASS
TWO MINUTES' WALK FROM ROWE'S WHARF STATION OF BOSTON ELEVATED RAILWAY

A. B. SEE
ELECTRIC
ELEVATORS
Established 1883

ELECTRIC ELEVATORS OF ALL TYPES

OFFICES
New York
Boston
Hartford
Jersey City
Philadelphia
Washington
Baltimore
Cleveland
Montreal
Toronto

WORKS
Jersey City
New Jersey
Montreal
Canada

BOSTON OFFICE
Minot Building
111 Devonshire St.

EASTERN BRIDGE
— AND —
STRUCTURAL CO.
Worcester, Massachusetts,
For Prices on all Classes of
STEEL AND IRON WORK.
WE DESIGN AND MANUFACTURE
ROOF TRUSSES, GIRDERS, COLUMNS, STAIRS
AND FIRE ESCAPES FOR BUILDINGS . . . .

FOOT BRIDGES, HIGHWAY BRIDGES, RAILROAD BRIDGES

We Carry a Large Stock of
I-BEAMS, PLATES AND ANGLES

Can Make Quick Deliveries. Send in Your Inquiries.

CONTRACTORS
LEY
SPRINGFIELD
MASS.

CAMP DEVENS WAS READY!

Army Cantonment at Ayer, Mass., Completed on Schedule Time

Demonstrating the Wisdom of awarding this Contract on a Cost Plus Percentage Basis

The 622 Buildings whose completion our schedule called for by September 1 were ready for the troops, and many of them occupied.

And 124 Buildings in Addition, including 46 of the 59 buildings needed for the 1,000-bed hospital unit, costing $500,000; refrigerating plants, storehouses, bakeries and miscellaneous buildings — all these completed ahead of schedule time.

Completing This $6,000,000 Contract on Schedule Time Necessitated:

- A Force of 9,000 Men
- A Weekly Payroll of $400,000
- $750,000 in Ready Cash
- Finishing One Building Every Forty Minutes for Two Months
- The Delivery of 30 Million Feet of Lumber
- Unloading 50 Carloads of Materials Daily
- Building a Complete Water Supply System with 20 Miles of Pipe
- Building a Complete Sewerage System with 20 Miles of Pipe

Capt. Canfield, in command of the Ayer Camp, informing us that Ayer headed the list of cantonments in percentage of completion, writes:

"This distinction should be a source of great gratification to your organization, as it is to mine."

FRED T. LEY & CO., Inc.

Contractors

BOSTON SPRINGFIELD NEW YORK

APPROVAL

HERSEY DETECTOR METER

The Hersey Detector Meter has been accepted for eleven years in 3," 4," 6," 8," 10" and 12" sizes without any restrictions or conditions of any kind by every Insurance Company, Stock and Mutual, doing business in the United States, and by the Water Departments and Water Companies in more than 500 Cities and Towns for use on over 3,000 Fire Services protecting nearly $2,000,000,000. worth of Insured Property.

HERSEY MANUFACTURING COMPANY

BOSTON	*COLUMBUS, O.*	*SAN FRANCISCO*
NEW YORK	*PHILADELPHIA*	*LOS ANGELES*
CHICAGO	*ATLANTA*	*PORTLAND, ORE.*

RATES FOR ADVERTISEMENTS

For one year — 10 issues

One page	$75.00
One-half page	40.00
One-quarter page	25.00
One-sixth page	17.50
One-eighth page	14.00
One-twelfth page	10.00

Last page, 50 per cent. additional.

For further information, or for contract forms, address

WILLIAM L. BUTCHER, Editor,
715 Tremont Temple, Boston

SAMUEL USHER
BOSTON